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JAMES BIRD,
Clerk of the London County Council.

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A statement of the conditions of the appointment will be sent by the SECRETARY on application.

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ANDREW BENNETT, Secretary.

The University,
St. Andrews,
March 8, 1920.

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Forms of application, with three references or testimonials, to be returned to the undersigned by March 29. The date must be stated on which the applicant could take up the position, if elected.

HERBERT REED,
Chief Education Officer.

Education Offices,
15 John Street, Sunderland.
March 9, 1920.

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F. C. SMITHARD,
Secretary to the Education Committee.

Education Offices,
Becket Street, Derby,
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AWARD OF TATE AND MORGAN SCHOLARSHIPS FOR SESSION 1920–21.

The Examinations for the award of Scholarships in Engineering, Science, Domestic Science, Hygiene and Physiology, and Art will be held on Tuesday, June 8, 1920, and the succeeding days. The Scholarships vary in value from £20 to £30 per annum, with free tuition, and are tenable from two to three years.

Last day of entry, May 1, 1920.

Full particulars on application to the SECRETARY.

CITY AND COUNTY BOROUGH OF BELFAST.

The TECHNICAL INSTRUCTION COMMITTEE invite applications for the position of LECTURER in BLEACHING, DYEING, and FINISHING, at the MUNICIPAL TECHNICAL INSTITUTE, BELFAST.

Salary £400 per annum, including bonus, rising to £500 per annum.

Particulars of the duties and conditions of appointment, together with form of application, may be obtained from the undersigned, with whom applications on the special form provided for the purpose must be lodged not later than MONDAY, APRIL 5, 1920.

Applications should be accompanied by copies of three recent testimonials (original testimonials must not be sent).

Canvassing is strictly forbidden and will disqualify.

RUPERT STANLEY, Principal.

Municipal Technical Institute,
Belfast.

THURSDAY, MARCH 18, 1920.

Science and the New Army.

THE memorandum of the Secretary of State for War relating to the Army Estimates for 1920-21, which has been recently issued by the War Office "in amplification of the speech of the Secretary of State introducing the Army Estimates" (Cmd. 565, price 3*d*.), is a notable document in both its national and scientific aspects. It represents the introduction of a new attitude towards military and medical science, as is shown by the following quotations:—

"We must continue to develop the power of our armaments, not by accumulating large stocks of weapons and stores for a great national Army in peace time of patterns that may become obsolete before they are used, but by scientific research and experiment which will lead to the design of the best types, and by preparation which will enable bulk production to commence without the unfortunate delays that had such a lamentable effect during the early stages of the Great War. . . . It is necessary to make adequate provision for research experiments and design in connection with war material. . . . We must, unfortunately, continue our studies of what is known as chemical warfare. . . . It is our policy to farm out to civil scientific institutions, such as the universities, the National Physical Laboratory, the Imperial College of Science and Technology, etc., all pure research that can be profitably farmed out, and, generally speaking, to restrict military institutions to applied research and the preliminary design of apparatus."

More could be quoted to encourage the belief that the Army has learnt its lesson, and, besides, there is the new Education Corps, as well as changes at Woolwich, Sandhurst, and the staff colleges, and new Army schools.

Those men of science who have served in the Army and were at times driven to despair by its patterns that have become obsolete in high places may be slow to believe in the seeming change of heart. With this memorandum before us, however, we are given reason for hope in improved conditions, and should assist in realising them. It is undeniable that, broadly speaking, early in the war, the Army was perilously out of touch and out of comprehension with respect to science, but it must also be remembered that the forces of science were not marshalled and led by any means so well as they might have been. The chemists, it is true, made an attempt to organise, but when they approached the Board of Trade with the view of establishing something like a clearing house, they succumbed to a strange *non sequitur* in the form of an assurance that the Government was going to establish a Department of Scientific and Industrial Research. Before and after that, chemists drifted to their various posts under a variety of currents, which only too often put a wrong man in a place for which the right one was equally available.

No doubt wonders were done, but it is surely most desirable that, for the future, science should have some scheme of mobilisation ready. In saying this, it is not suggested that a rigid scheme could, or should, be attempted, but there is something between detachment and regimentation that is better than either, and this at least it should not pass the wit of man to design.

Over-organisation is one of the reactionary extravagances of the war, and it is evident to some degree in the memorandum before us. Some pride appears to be taken for the provision of Co-ordinating Boards, which among other things "should lead to the detection of overlap [in research] where such exists, and its elimination." Overlap is the bogey of the official mind, and co-ordination the blessed word. So far as the advancement of science for peace or war is concerned, let us hope that philosophers will go to the stake rather than be deprived of their right to overlap anybody or anything they may choose.

The overlap of chemistry and physics is maintaining the credit of our country in science; an equal overlap of the General Staff of the Army and the brotherhood of science, if it can be achieved, will do also much for the safety of the country. That is the vital thing for which there is perhaps some promise, but not yet adequate assurance. Science linked to the Army by fussy research co-ordinators acting under a nescient soldier will not solve the difficulty. It is perhaps too much to expect that all officers on the General Staff will have had a scientific education, but until it is made obligatory for a proportion of them to have had such a training, the fundamental reform will not have been effected, and science will not occupy its rightful position in the new Army.

The section of the memorandum which relates to the Royal Army Medical Corps is of noteworthy interest. An important feature is the reorganisation of the medical section of the Territorial Army under the supervision of a Territorial section of the War Office. In view of the fine work which was done by Territorial units during the war, it is

to be hoped that this branch of the Medical Corps will be given the opportunities it deserves. The proposal to form a dental corps is indeed excellent, and it might be advantageous to unite with this the plastic surgery which was so intimately associated with dental work in the late war.

In our opinion one of the best changes in the Army medical administration is the establishment of the new directorates of pathology and hygiene; an important consequence of this is that promotion to the highest rank is now open to the specialists who take up such work in the Army. Efficient collaboration with the civil profession and with other branches of State medical work will be ensured by the aid of an advisory committee of experts, both civil and military. It may be assumed that the work hitherto carried on by the vaccine department of the Royal Army Medical College will henceforth be taken under the directorates of pathology and hygiene. The figures given in the memorandum show how largely the work of the vaccine department aided in maintaining the health of the troops in the field, and with a very much smaller expenditure than would have been entailed in private purchase. More than 33,000,000 doses of vaccines of various types were prepared during the last five years; the value of the vaccines is well illustrated by the case of the protection afforded against the typhoid group of diseases. In the French Army, before full protection against typhoid, there were from the outbreak of the war until the end of October, 1915, 95,809 cases, with 11,690 deaths; after the adoption of treatment the French figures were comparable with our own—during the entire war we had 7423 cases, with 266 deaths, in our Expeditionary Force in France.

The future of gas warfare is briefly dealt with in the memorandum. This form of offensive has evidently come to stay, and it is stated that, owing to the fact that preparations for the use of gas can be made in peace time with great secrecy, it is necessary continually to study defensive measures capable of meeting such a form of attack. Defence against gas involves physiological, quite as much as chemical, measures, as is shown by the important part played by physiologists in the elaboration of the British box respirator, which is the most perfect and wearable defence against all gases hitherto employed in war. It is to be hoped that the War Office will continue to consult both physiological and chemical experts in problems connected with the construction of respirators, and also in the arrangements for training troops in such devices.

The Roast Beef of Old England.

Cattle and the Future of Beef-Production in England. By K. J. J. Mackenzie. With a preface and chapter by Dr. F. H. A. Marshall. Pp. xi + 168. (Cambridge: At the University Press, 1919.) Price 7*s.* 6*d.* net.

WITH the advent of peace, British agriculture, still harassed and bewildered by the vagaries of a "control," painful, like a tooth, in its going as in its coming, has entered upon a transition stage towards the establishment of a new equilibrium, the character of which must be a subject of anxious concern to all who believe that a prosperous and contented agriculture is the soundest basis upon which the national welfare can rest. At this juncture wise counsel is needed from those best qualified to give it, and it will find a more sympathetic hearing than was wont to be the case in the bygone days when farming was so generally looked upon more as a mode of life than as a complex industry of vital importance to the nation, and requiring the sympathetic and active support of the community.

The change in the direction of an increase of plough-land at the expense of grass-land, which was forced upon the industry by the necessities of war, is already in process of reversal, and this return to grass is likely to proceed at an increasing rate unless clear evidence is forthcoming that arable farming for some years to come is likely to give such enhanced profits as compared with grass farming as will compensate adequately for the greater worries and outlay it entails. The gain to national security which the increased supply of home-grown breadstuffs obtainable from an enlarged arable acreage can confer is obvious, and that this is at the same time consistent with a profitable system of agriculture is amply demonstrated in the practice of Germany, Belgium, and the Scandinavian countries, where systems designed essentially for the production of corn, vegetables, and milk prevail.

It must not be too readily assumed, however, that these systems are directly applicable to British conditions, which differ in many respects, and, Mr. Mackenzie would warn us, in none more vitally than in the more refined taste in meat, *par excellence* beef, which marks us out as a race apart. The German and the Dutchman are apparently condemned by their systems of agriculture to a beef mainly derived from the carcasses of worn-out milch cows and draught oxen, but who could forecast the consequences of a change in our agriculture which would restrict the British workman—and the British cook—to such fare! Mr. Mackenzie has no doubt that it would lead to "a

general fall in our national standard of life," and have "a very pernicious effect on the efficiency of our race."

He would postulate, therefore, that no system of agriculture can be sound for this country unless it provide for an abundant supply of prime beef. We must hasten to explain, however, that he is no advocate of reversion to grass farming, which, indeed, he condemns roundly as "stealing from the land." Nor is he satisfied with other current systems of beef production. Taking the various systems at present in vogue, he has no difficulty in demonstrating that on the average British farm even the best of them represents but a very inefficient use of the possibilities of the soil.

A great deal of our grass-land can be made far more productive by suitable ameliorative treatment, but more fundamental than this is the need for improvement of the general quality of our breeding stock. It cannot be denied that, despite the pre-eminence of our best stock, the general level of quality of cattle found on the majority of our farms is deplorably low. This is in some measure due to the great development of our export of cattle, which has given to the foreigner the pick, whilst leaving for the home farmer only the moderate animals and the outcasts of our pedigree herds. Moreover, the class of animal which the foreigner demands is not that which is best suited to the present home requirements.

The export trade must continue to be an important feature of our pedigree stock raising, but it is high time that organised effort should be made through State action with the co-operation of landed proprietors and agricultural associations to encourage the development of types of cattle especially suited for our own purposes and to ensure their distribution over the farms of the country. With an improved type of cow, capable of producing a good yield of milk and early-maturing, well-fleshed progeny, it will be possible to combine intensive cultivation with the production at reasonable cost of the milk, beef, cheese, butter, and veal which the maintenance of a high standard of living requires.

There are many signs that the line of reorganisation which Mr. Mackenzie indicates is the one which British agriculture is most likely to follow, and it is sincerely to be hoped that his book will circulate widely amongst the leaders of agricultural opinion and the farming community generally. Last, but not least, his exposition of the need for greater provision for research in animal husbandry must be warmly commended. Without this the improvement of live-stock must remain to a large extent a blind groping after ends incapable of precise definition. C. C.

French Text-books of Chemistry.

(1) *Notions Fondamentales de Chimie Organique.* By Prof. Charles Moureu. Sixième édition. Pp. vii + 552. (Paris: Gauthier-Villars et Cie, 1919.) Price 16 francs.

(2) *Cours de Chimie à l'usage des Etudiants P.C.N. et S.P.C.N.* By Prof. R. de Forcrand. Deuxième édition. Tome 1. *Généralités—Chimie minérale.* Pp. viii + 437. Tome 2. *Chimie organique—Chimie analytique; Applications numériques.* Pp. 527. (Paris: Gauthier-Villars et Cie, 1919.) Price 14 francs and 18 francs respectively.

(1) AS a science develops and facts multiply and group themselves into laws and theories, the system of imparting knowledge is greatly simplified by using these generalisations as pegs upon which to hang the facts. Whilst this process is of the very essence of scientific growth, it is important not only that the theories should clothe the facts, but also that the tight or loose parts of the garment should be clearly marked in sartorial fashion for future modification. Nothing is more misleading than the attempt to adjust a theory by implication or by omission of details to limbs it does not fit. How flabby many a theory has looked on close inspection!

Herein lies a danger into which present writers on organic chemistry may fall. The mere enumeration of compounds has been replaced by the description of a few typical examples, and broad generalisations have been illustrated and condensed into a few paragraphs. This system of condensation, whilst it affords a useful survey of the whole region of organic chemistry, may in the process omit those apparently insignificant exceptions which, like the minute foreign substances in metals, modify the whole character of the material.

We have been led to express these views in the perusal of Prof. Moureu's treatise.

The fact that it has reached a sixth edition is sufficient evidence that, whatever its merits or defects, the book has established itself as a popular text-book, and that it should have so established itself is easy to understand.

The number of compounds described, though sufficiently numerous, is not more than is necessary to illustrate some general process. Each chapter and section is introduced by a few paragraphs on *généralités*, admirably and lucidly explained. The weak point of these *généralités* is their brevity. They merely touch the fringe of the subject, and as there are no references, the student is not encouraged to bridge the gaps. Tautomerism, which finds a place under ketonic acids, is dismissed in less than three pages.

Each new subject is introduced by a string of names of distinguished chemists who have been concerned in its study (sometimes as many as eight are given), but there is no indication of the nature of their contributions, and again no references are given. Incidentally, it may be pointed out that the names of French chemists are much in evidence. Under "Valency," Frankland's name is not even mentioned. These are minor points.

The arrangement, though somewhat novel to English chemists, is finding favour both in France and in America. There is no division into aliphatic and aromatic compounds, but the two are combined. Thus chap. ii. includes all the hydrocarbons, saturated and unsaturated, aromatic and hydro-aromatic, and the same system is followed throughout. The nitrogen compounds have a chapter to themselves, and there are others on organo-metallic compounds, heterocyclic compounds, and colouring matters.

(2) Prof. de Forcrand's class-book of chemistry, which has reached a second edition, is written for students who are entering on a course for the P.C.N. and S.P.C.N.—that is to say, a certificate sanctioned by the Ministry of Public Instruction for advanced study in physics, chemistry, and the natural sciences, the P.C.N. representing a standard intermediate between the *baccalauréat* and the *licencié* in science, and the S.P.C.N. being the equivalent of the latter.

The course is divided into two parts, inorganic and organic, which are treated in separate volumes. The inorganic section is divided into *généralités*, metalloids, and metals. The book is not intended for, nor is it to be recommended to, beginners. The general principles laid down in the first section, which include such notions as reversible and isomeric changes, the phase law, mass action, displacement of equilibria, etc., would be almost meaningless unless the student were already acquainted with the phenomena upon which these generalisations are built. Moreover, the subjects are presented in a didactic manner, in which general statements are laid down without any attempt at adducing evidence for them.

It seems to the writer that the old method, which was so common formerly among authors of science text-books, of introducing general principles and definitions before any experimental facts had been discussed, though perhaps philosophically sound, is not the best way of applying the experimental method—that is, the method of reasoning from facts to generalisations—and not only so, but it is almost bound to lead, as in the present case, to didactic treatment.

The same criticism applies to the volume on organic chemistry. The linking of carbon atoms by single and multiple bonds is assumed without evidence, and so also is the structure of the various organic groups.

Generally speaking, the book is somewhat old-fashioned in its arrangement, in spite of paragraphs on modern topics. It suffers, too, from a dearth of illustrations. Even if the student has studied his subject experimentally, and is acquainted with apparatus and methods, he is still ignorant of many practical operations of a technical character or special apparatus used in the preparation of rarer compounds which some good drawings would help him to grasp.

Having pointed out what seem to the writer the chief defects of treatment, it should be added that the information is well arranged, and covers the most important facts without unnecessarily multiplying the number of compounds. It is curious to find the subject of analytical chemistry, both inorganic and organic, relegated to the end of the volume on organic chemistry.

J. B. C.

Indian Beetles.

The Fauna of British India, including Ceylon and Burma. Coleoptera. Chrysomelidae (Hispinae and Cassidinae). By Prof. S. Maulik. Pp. xi+439. (London: Taylor and Francis, July, 1919.) Price 1 guinea.

THERE is evidence enough in this volume to show that many months of assiduous work must have gone to its preparation; but it leaves more than an impression that the author lacked experience to begin with, and had not quite mastered his subject. His descriptions are generally too long. An author of experience, using better judgment, would have confined his attention to essentials when describing species, and left out the rest, thus saving himself and his readers both time and trouble. It would have meant a lot in a volume like this, where 388 species altogether come under notice, and all but a few are described at length. Where the descriptions are long and the differential characters not clearly marked out, the keys to genera and species need to be well constructed and trustworthy.

Prof. Maulik's keys do not always answer to this description. His keys to species not infrequently contain diagnoses which, though fairly long, are not quite long enough to enable the text descriptions to be dispensed with altogether; and the key to his first group of genera is of so little service that the reader is left to decide which is the more to be trusted, the author or his artist, the key or the text. He has nowhere

explained why he has rejected certain characters made use of with great success by Chapuis in his grouping of the genera of Hispinæ; and it is to be noticed also that he has not stated why there is so very rarely any reference to sexual differences in his descriptions, either of genera or of species, which otherwise appear to show close observation.

About ninety of the species described are the author's own, and to many of these he has given names which, derived from the ancient language of his country, form a novel and interesting feature of the book. In a short introduction to each sub-family an account is given of the few larvæ and life-histories known, and a list of useful references to other works in which information about them may be found. Mimicry in the Hispinæ is touched upon, and Gahan's observations on the interesting stridulatory structures met with in the same sub-family are quoted almost in full, but without reference to the value they were expected to have for systematic purposes.

The volume is well illustrated, and the figures, all greatly enlarged, appear to be carefully drawn, with the exception of one on p. 86, which is not what it is said to be—the "mentum" of a genus which is unique amongst the Chrysomelidæ in having no labial palpi. Were it not for defects of the kind pointed out, and frequent signs of carelessness in the text, the volume, on the whole, would deserve much praise, due regard being given to the fact that it is the author's first essay in systematic work on more than a small scale.

C. J. G.

Mathematics: Pure and Applied.

(1) *The Fundamental Equations of Dynamics and its Main Co-ordinate Systems Vectorially Treated and Illustrated from Rigid Dynamics.* By Frederick Slate. (Semi-centennial Publications of the University of California.) Pp. ix + 233. (Berkeley: University of California Press, 1918.)

(2) *Projective Vector Algebra: An Algebra of Vectors Independent of the Axioms of Congruence and of Parallels.* By Dr. L. Silberstein. Pp. vii + 78. (London: G. Bell and Sons, Ltd., 1919.) Price 7*s.* 6*d.* net.

(3) *Elements of Graphic Dynamics: An Elementary Text-book for Students of Mechanics and Engineering.* By Ewart S. Andrews. Pp. viii + 192. (London: Chapman and Hall, Ltd., 1919.) Price 10*s.* 6*d.* net.

(4) *Differential Calculus for Colleges and Secondary Schools.* By Dr. Charles Davison. (Cambridge Mathematical Series.) Pp. viii + 309. (London: G. Bell and Sons, Ltd., 1919.) Price 6*s.*

(5) *The Analytical Geometry of the Straight Line and the Circle.* By John Milne. (Bell's Mathematical Series.) Pp. xii + 243. (London: G. Bell and Sons, Ltd., 1919.) Price 5*s.*

(1) MANIFOLD adaptations of dynamical reasoning have given rise to specialised treatises of undoubted excellence. Prof. Slate sets himself the task of surveying the common foundation and the common stock of resources of these adaptations, as well as the trend of modern development in dynamics. Six quantities enter into the formulation of fundamental dynamical principles: force, power, and force-moment on one hand, momentum, kinetic energy and moment of momentum on the other. Each triad can be, and has been, used in the enunciations of dynamics. But the enunciations involve the use of reference-frames, leading to the question of the relativity of such frames and the transformation from one frame to another—both when the transformation is that of a mere translation, and when it partakes of the more general form of a shift and a rotation. The author considers these transformations and the chief kinds of co-ordinate systems. Euler's and Lagrange's equations, and their use in the study of the dynamics of a rigid body, conclude a presentation possessing considerable interest and originality. A number of notes are added containing references and further elucidations.

An objectionable feature of the book, and one that destroys much of its value, is the difficult English in which it is written. The most intelligible portions are those consisting of mathematical symbolism—the accompanying letterpress is often a puzzle. What is one, *e.g.*, to make of the following?—

"In consequence it has not been displaced as a tenet of orthodox dynamical doctrine that standards by which to judge of the energy, momentum and force that ought to appear in its accounts will not stand on a par if adopted at random, however interchangeable they have proved in passing upon rest, velocity and acceleration by the mathematical criteria in the more indifferent domain of kinematics."

The impression one has in reading the book is that of a laborious progress over a succession of obstacles. Not every reader can be expected to persevere when so many of the obstacles are due to the guide whose function it should be to remove such difficulties as are inherent in the subject.

(2) In Dr. Silberstein's book on "Projective

Vector Algebra" we have a very lucid exposition of a subject somewhat removed from the ordinary interests of the mathematical teacher or researcher. Vectorial representation is a common feature of many branches of physical science, and the author's share in the encouragement of the use of vectorial methods amply justifies his further contributions to the discussion of the nature and properties of vectors, whether as means of calculation and research, or as illustrative of fundamental geometrical properties of space. The present book aims at the construction of an algebra of vectors, based solely on the axioms of connection and of order. Only addition and subtraction of unlocalised vectors are dealt with in the book itself; in a subsequent paper in the *Philosophical Magazine* the treatment is extended so as to include multiplication and division.

Opinions may differ as to the utility of the system thus constructed; there does not seem to be any obvious application of the ideas to the discovery of new results in pure mathematics or in investigations of a physical character. But the methods are elegant, and the exposition is admirable. The proofs afforded of theorems on the projective geometry of rectilinear figures and conics amply repay the few pleasant hours spent in reading the book and its continuation in the above-mentioned paper. One may perhaps question whether the book is really adapted for "beginners in geometry."

It would have added to the value of the investigation if the book had been divided into chapters and a reasonable number of examples inserted for exercise in the methods developed. The construction for scalar multiples of a vector admits of some simplification.

(3) This is a useful account of the application of graphical methods to dynamical problems, especially such as are of an engineering character. The process of graphical integration is applied to work, to space, to velocity and acceleration, and to action, the auxiliary parabola being used for the last. Polar diagrams are used with special application to simple harmonic motion and to combinations of simple harmonic motions, to cams, etc. Velocities changing in direction are then considered with applications to rotating bodies and the turbine. Linkages and static forces in mechanisms are followed by the elements of flywheel design and the theory of the balancing of rotating parts. There are many diagrams and exercises.

Though primarily intended for the engineer, the book contains much that should be incorporated into ordinary elementary courses on dynamics. Actual live problems with their practical solutions are far more valuable, pedagogically, than the numerous artificial exercises that are given in so many of the books written "for schools and colleges."

Mr. Andrews should take more pains with his notation; the needless use of x for ordinates must surely annoy the student. The statement

$$\text{mean effort} = \frac{\text{area below curve}}{\text{length of curve}}$$

(p. 14) needs obvious correction. The definition of work on p. 34 applies only to a force constant in magnitude and direction. On p. 47 simple harmonic motion is defined in the usual manner, but with the addition that the force acts in a direction opposite to the direction of motion of the body. This is not an oversight, for it is repeated on p. 64!

(4) This is not a book for beginners, although Dr. Davison follows the usual practice of indicating what might be omitted on a first reading. The whole book should be put aside on a first reading of the subject, and a more suitable presentation selected for the purpose.

But the student who has already mastered the elements of the calculus, and understands the meaning of a limit and the notion of differentiation and integration, is ready for Dr. Davison's book. It is brief, yet full. Part i. contains first principles—*i.e.* differentiation, successive differentiation, expansions, and indeterminate forms. Part ii. deals with the applications to maxima and minima, and to the theory of curves, including curvature, asymptotes, singular points, curve-tracing in Cartesian and in polar co-ordinates, envelopes, evolutes, and pedals. There are numerous examples, including sets of revision exercises. Two excellent features are the problem papers and the suggestions for a number of mathematical essays. The form of the book is pleasant, and the diagrams are well drawn and reproduced.

A few improvements are possible. Thus §§ 28 and 34 are ambiguously worded. There is a trap in the formulæ of § 61. In the chapter on polar co-ordinates nothing is said about the ambiguity inherent in polar equations, as mentioned in these columns in a recent review of another book. These are but a few blemishes in what is an excellent production on well-known traditional lines.

(5) There is much excellent matter in Mr. Milne's discussion of the analytical geometry of the straight line and circle. The treatment is lucid and such as will appeal to the beginner; the subject-matter is very well chosen, and presented in abundant detail with numerous illustrative exercises, both worked and unworked.

It is difficult, however, to recommend the book for general use in schools. Attention has been directed on several occasions to defective figures in elementary mathematical text-books. In Mr. Milne's book the fault exists in an accentuated degree. No attempt seems to have been made to co-ordinate the diagrams and the letterpress, whilst many of the diagrams printed on squared paper contain actual mistakes. These criticisms apply to diagrams on pp. 3, 34, 35, 36–37, 38, 53, 55, 58, 59, 63, 72, 74, 88, 92, 120, 123, 128, 129, 143 (a very bad case), 147, 148, 155, 157, 166, 179. It is surely not right to place such diagrams before young students.

If the book were re-issued with correctly drawn diagrams, it would constitute a valuable addition to school and college text-books.

S. BRODETSKY.

Our Bookshelf.

The British Journal Photographic Almanac and Photographer's Daily Companion, 1920. Edited by George E. Brown. Pp. 912. (London: Henry Greenwood and Co., Ltd.) Price 1*s*. 6*d*. net.

ALTHOUGH this volume has not quite reached its pre-war bulk, it has gone a long way towards it, and appears to be now lacking only a little in its former plethora of advertisements. Unfavourable conditions still hold, but the editor has been able to restore the tables, formulæ, and other technical details that photographers have for so many years been in the habit of consulting in their daily work. The "Epitome of Progress" is a good summary of the novelties of the past year, and there is, we think for the first time, a "History in Brief of Photographic and Photomechanical Processes." The nine pages devoted to this subject will be of special interest to the student, for they give the dates of a very large number of important facts connected with the development of photography, starting from the very beginning. We notice that sensitol red and sensitol green are ascribed to Prof. Pope in 1917. We always thought that these were pinacyanol and pinaverdol, respectively, of German origin some years previously, and that to Prof. Pope was due the credit of preparing them in this country, and also of introducing sensitol violet, which, however, does not appear to be mentioned. The section on "Beginners' Failures in Photography," by the editor, deserves much appreciation. C. J.

Toxines et Antitoxines. By M. Nicolle, E. Césari, and C. Jouan. Pp. viii+123. (Paris: Masson et Cie, 1919.) Price 5 francs net.

M. NICOLLE holds such a high place among those who have made contributions of real importance to our knowledge of parasites that it seems a pity he should put out this disorderly summary of some of the researches of himself and his collaborators. It reads like a bundle of notes that a man might make to define the current position of his investigations, and to settle which piece of work he should take up next. With trivial exceptions M. Nicolle reviews no facts but those of his own discovery, and it is impossible to distinguish between conclusions and hypotheses. He points out, for example, the similarity of symptoms and anatomical lesions produced by various toxins of different origins, and the diversity and specificity of the antibodies which result from their introduction into the animal economy. He therefore concludes that toxins consist of two parts, one poisonous and not an antigen, the other inactive and an antigen. This is no more than a possibly fruitful hypothesis on which to base further experimentation. Those who know the subject well might run through the book with advantage; others had better leave it alone. A. E. B.

Some Wonders of Matter. By the Right Rev. Dr. J. E. Mercer. Pp. 195. (London: S.P.C.K.; New York: The Macmillan Co., 1919.) Price 5*s*. net.

BISHOP MERCER writes for children, and in a manner in accordance with the Child's Guide of our grandparents rather than with modern educational ideals. His primary concern is to excite the naïve wonder which he considers so valuable; so he makes no selection, but ranges apparently at random from Pharaoh's serpents to Brownian motion without giving any clue to the relative importance of the very varied matters at which he glances. So wide a range in so small a space would tax severely the highest powers of exposition, and Bishop Mercer has not the genius for happy analogy that is characteristic of all the most successful writers for the young. Again, though the work is free from serious error, we judge that its author has not a first-hand acquaintance with science. If he had, he would scarcely puzzle the brains of his small charges (and incidentally that of the reviewer) by raising questions no serious student of science would ask—those, for example, which give rise to the paradoxes of Berkeleyan idealism. On the other hand, some parents will welcome the definitely religious tone and be gratified that the Divine Intelligence is presented in a form sympathetic to the simplest.

An Arithmetic for Preparatory Schools. With Answers. By Trevor Dennis. Second edition, revised. (Bell's Mathematical Series.) Pp. xiv+376. (London: G. Bell and Sons, Ltd., 1919.) Price 4*s*. 6*d*.

MR. DENNIS'S "Arithmetic" well deserves the second edition which it has reached. The sequence is based on the syllabus of mathematical teaching for ages nine to sixteen, for non-specialists, issued by the Curriculum Committee of the Headmasters' Conference. Suitably chosen exercises and clear type make the book well adapted for the students for whom it is intended.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Museums and the State.

I HAVE read with deep interest the leading article entitled "The State and the National Museums" which appeared in NATURE of March 11. As a zoologist my interest is chiefly centred in the Natural History Museum at South Kensington, and I most heartily agree with the statement that "the development of the Natural History Museum has been grievously hampered by the persistent attempt made to fit it to a system devised . . . especially for the great library [at Bloomsbury], which has, in fact, always tended to overshadow the rest of the museum."

Historically, as you point out, the museum at South Kensington is the offspring of the mother institution at Bloomsbury, but the daughter is now fully grown up, and should be completely free from parental control. It seems quite anomalous that a man chosen for his knowledge of antiquities and literature should be the supreme head over the greatest collections of animals and plants which exist anywhere in the world.

Few Englishmen have any adequate idea of the value of the asset represented by these collections. Most of them, like Lord Sudeley, whom you quote, regard the museum merely as an instrument of popular education. But this is only one of its lesser functions. Its main value lies in the fact that it is the repository of type-specimens of the majority of the determined species of animals and plants. In these days of the energetic development of newer lines of research in zoology, it must never be forgotten that systematic zoology is the basal science, the pre-requisite for successful advance in any other branch of the subject.

Just as it is necessary that standard measures of length, weight, etc., should be stored in some central repository, so it is necessary that there should be a central institution in which every biologist should be able to determine accurately the species with which he is working. The agriculturists of Mauritius are bothered by an insect pest which they regard as identical with one of the common insects of the island. Measures are taken for its extermination, and these prove unsuccessful. It is then discovered, on reference of the matter to South Kensington, that the pest is a foreign one accidentally imported from the West Indies! Examples of this kind could be multiplied indefinitely, but one more may suffice. The fishery authorities of South Africa desired to introduce the herring into their coastal waters, but the experts at South Kensington were able to point out that, although different species of herring exist in various parts of the world, in both northern and southern hemispheres and east and west, yet all these species are confined within the limits prescribed by two isotherms of annual temperatures, and that South Africa lies outside these limits; so that if herring were liberated near its coast, they would, if they survived, at once swim southward into cooler waters.

The supreme government of the two museums at Bloomsbury and South Kensington is vested in three principal trustees, viz. the Archbishop of Canterbury, the Chancellor of the Exchequer, and the Speaker of the House of Commons, not one of whom has any necessary connection with or knowledge of science.

The scantiness of this knowledge may, indeed, be gauged by the scornful remarks made by the Speaker during the war in reference to the alleged purely academic interest of studies on Microlepidoptera at the very time that the War Office was imploring the aid of specialists in this department in fighting a pest which was destroying its stores of biscuits.

The article in NATURE advocates placing the museum under the control of a Government Department—"*Timeo Danaos et dona ferentes.*" It seems to me that the ideal of the present Government, viz. a small committee of broad-minded men, is the correct one; only the *personnel* requires to be changed.

It has been cynically observed that the constitution of the present committee was chosen at a time when the Archbishop, the Chancellor of the Exchequer, and the Speaker were the three men in England least likely to be bribed. If for them were substituted the presidents of the Royal Society, of the Zoological Society, and of the Geological Society, the control of the museum would be in the hands of a committee of scientific eminence, and one peculiarly susceptible to the pressure of scientific opinion.

In view of the unique importance of the collections, it is surely essential to have a distinguished man of science presiding over each division of the collection, and for the services of such a man the museum ought to be in a position to pay generously. In the past the museum has been far better served than it deserved to be; it has, in fact, exploited the scientific enthusiasm of young men. In the long run, however, low pay will evoke inferior service. As the present holders of positions in the museum die or resign, clever men will be reluctant to step into their places if to do so means to embrace a life of poverty. A governing body such as I suggest would be in a far better position to estimate the real value of the services of these experts than one which is too much inclined to regard them as a set of obscure academic recluses.

E. W. MACBRIDE.

Royal College of Science, Zoological Department, South Kensington, London, S.W., March 12.

THE leading article in NATURE of March 11 on "The State and the National Museums" directs attention to a reform the need for which has been increasingly felt by those especially interested in our great national museums. Your summary of their haphazard history explains why their relation to the Government is out of date; why between them there is an overlap which, despite the advantage of competition, causes waste and inconvenience and is a hindrance to efficiency; and why our Museum of Natural Science is administered by a board of trustees planned—so far as it was planned and has not been a fortuitous aggregate of distinguished men—in reference to the library and departments at Bloomsbury. The titles of the museums are a product of this erratic growth and misleading to the public; the Natural History Museum is actually the British Museum of Natural Science, since, according to recent usage (*cf. e.g.* Webster's Dictionary), natural history is restricted to zoology, or perhaps to biology, while the adjacent museum is the British Museum of Physical Science.

Dissatisfaction with our museum administrative system has been clearly growing for years, but there has been no particular opportunity to secure reform or to organise a sufficient body of opinion to convince the Government of its need. Now, however, the establishment of the Department of Scientific and Industrial Research has provided an organisation to which the management of the scientific museums might be appropriately entrusted.

The suggestion, however, to extend that Department so as to include all learning and research requires cautious consideration, since it would throw on that

Department duties so dissimilar as the management of scientific and artistic collections, and would jeopardise its scientific position. One great advantage of that Department is that it provides one strong and influential organisation devoted to the development and utilisation of science; but if it had to control all literary and classical research its aims would be diffuse, and pure science, between the claims of the "humanistic" and industrial sections, might fare poorly.

To unite all our museums, artistic and antiquarian, classical and commercial, scientific and military, under one control would maintain the practice that a museum is a "raree" show, and be inconsistent with the modern principle that a museum is primarily a laboratory of which the general policy should be determined by the authorities in its own department of knowledge. To place a technical or research museum under the Board of Education is as anomalous as to place some other museums under a research department. There are museums in London—for example, that at Bethnal Green—which would be appropriately managed by the Board of Education or by the Education Committee of the London Country Council as the demonstration department of the East London schools.

The foundation and original endowment of the British Museum by a State lottery introduced into British museum policy a virus of chance, which has since been a potent factor in the development of the museums; but a commission of inquiry might now secure sufficient support to establish them on a firmer foundation and utilise the unique opportunities of London as the home of a well co-ordinated group of world-representative museums. The present medley, in spite of its unrivalled material, is being outclassed by the museums of America. J. W. GREGORY.

4 Park Quadrant, Glasgow.

THOSE who have long viewed with increasing irritation the waste of time, labour, and money involved in the present unco-ordinated condition of our national museums will welcome the leading article in NATURE of March 11, in which you have with such justice expounded the situation and indicated a possible solution of our difficulties. It is a little dangerous for a Civil Servant to express a candid opinion on the workings of Government Departments, but perhaps I may be allowed to go outside that taboo area and to point out that the duplication of work and the competition for specimens to which you have alluded affect all the museums (including art galleries) of the country. Some of us, therefore, have come to the conclusion that these also should be co-ordinated with the national institutions and knit into a single scheme. There need be no interference with the existing direction of each museum, but there could be much organised help.

We of the geological department of the British Museum do, in a small, disjointed way, try to help our colleagues of other museums, and we receive help from them. But this is just enough to let us imagine what could be done if such mutual aid were placed on a recognised footing; if, for instance, the small band of museum palæontologists of Great Britain (and Ireland?) was so organised as to cover the field, and so employed that each specialist could help and advise on his own subject in all museums as part of his official duties. At the first meeting of the Museums Association in 1890 a committee was appointed to consider some such co-operation, but little practical result has ensued, not for lack of goodwill, but because existing conditions stand in the way. What applies to palæontology applies to all other branches of knowledge. But this is only one of the improvements that might spring from a reform such as we have in view.

Many other good results there could be, among them, perhaps, a better training for curators. But that the results shall be good it is necessary for the directing board to be composed of men with museum sympathies and experience. Therefore, whether the Ministry be that of Education or some new Ministry of Learning and Research, it should exert its financial or other control over museums through a special museum board. In this way those branches of museum work which do not meet the public eye would run less risk of being overlooked. Any large natural history or other science museum is part of the armament employed by man in his unceasing warfare against the forces of Nature. Intellectually and economically that is its main purpose. As the Earl of Crawford, in replying for the Government on the debate raised by Lord Sudeley, rightly said: "It is not the popular guide-books, but the technical and specialised publications issued by museums which really count. They are of vital importance." Visits to a museum, like visits to a battleship, may be of high educational value, especially under the guidance of a qualified demonstrator, but—well, the inference is obvious. Only one point needs emphasis. Museums, no less than battleships, should be under the administration of those familiar with the principles and methods of the respective warfares.

F. A. BATHER.

Wimbledon, March 13.

THE relation of the State to the national museums, and of the latter to each other, discussed in NATURE for March 11, is a matter calling for very careful consideration at the present time. A Ministry of Learning and Research, such as is there suggested, would render very useful service if it could (1) see that the governing body of each institution was composed of persons duly qualified for their work; (2) define the scope of each institution, so as to diminish the risk of competition for desirable specimens, and to provide each with a definite piece of work for the benefit of the community; (3) provide each institution with a due proportion of financial assistance; and (4) arrange such a scale of salaries as would ensure the appointment and retention of the brains best adapted for the purpose in view. At this point central control should cease, and each governing body be left to do its own work, with the assistance of its staff.

The proposal to place museums and libraries under the Board of Education, to which the article alludes, has no reference, I believe, to national museums, but I should like to place on record my strong disapproval of such a step. A museum has many duties to perform, and education in the sense in which the Board deals with it is only one, and not the most important, of them. On the basis of a very extensive acquaintance with provincial museum curators, I have no hesitation in saying that they are fully alive to the educational possibilities of their work. Many of them have rendered valuable service to the education authorities of their localities, and many more would have done so had they been permitted; but this does not prevent them from seeing that their museums have other functions to perform which do not fall within the purview of education committees as at present constituted. In the first place, they are storehouses of material for enlarging the bounds of human knowledge; secondly, they provide objects of interest and beauty for the intellectual and æsthetic contemplation of the citizen; and, thirdly, they furnish material for the university student, post-graduate and undergraduate, as well as for children of school age.

May I say in conclusion that, in my opinion, the

chief thing that is wrong with museums, national and provincial, is (as Bernard Shaw says of the poor) their poverty?

WM. EVANS HOYLE.

National Museum of Wales, Cardiff,
March 15.

IN the timely and suggestive leading article on museums in NATURE of March 11 there are references to the Museum of Practical Geology that need explanation, not because they are incorrect, but because they are symptomatic of that forgetfulness of the fundamental purposes of this museum which has long been obvious in some quarters.

It is true that "the Museum of Practical Geology was a necessary concomitant of the Geological Survey," but this was not, and never has been, its sole *raison d'être*. It was founded as the Museum of Economic Geology—that is, of economic geology in its broadest aspects. It had, therefore, from its inception two functions to perform: (1) To serve as the storehouse and exhibition for all the concrete documentary material collected during the making of the geological maps—material of the greatest value as a demonstration of the facts of British geology and usefully employed for educational, industrial, and purely scientific purposes; and (2) to act as the national repository of material illustrative of all those mineral resources that form the basis of mining, metallurgical, and other industries.

The first of these functions is purely British in scope, the second is world-wide.

As regards overlapping with the Natural History Museum, there is none; and alternatively, as the lawyers say, if there is any it should cease, since the functions of the two institutions are clearly differentiated. The scheme of the geological and mineralogical departments of the Natural History Museum is academic, and that of the Museum of Practical Geology economic. On the other hand, the Imperial Institute in respect of its mineral exhibits does overlap the functions of the older institution. This is a question requiring attention in any scheme of reconstruction.

WILLIAM G. WAGNER.

March 15.

Some Methods of Approximate Integration and of Computing Areas.

ENGINEERS and shipbuilders are continually requiring to find the area of a surface bounded by curved lines. If both the upper and lower boundaries are curved, it is a simple matter to divide the surface into two by a straight line, find the area of each part separately, and add them together.

Simpson's rule is almost universally used for this purpose, but a little consideration will show that a more accurate evaluation of the area can be obtained in most cases by using other rules.

We will consider an area contained by a base line, two vertical ordinates at the ends, and a number of intermediate ordinates placed at equal distances along the base line. If the base line be divided into m equal intervals, each of a length h, there will, of course, be $m+1$, or n, ordinates. When the height of these ordinates is known, and the value of h the interval also, an approximation to the value of the area can be obtained which increases in accuracy with the number of ordinates taken and measured, when the curve is of an anomalous shape.

(1) If the upper boundary be a straight line, an exact result will be obtained by merely the two end ordinates y_1 and y_2 and the length of the base line h; $A=\frac{1}{2}h(y_1+y_2)$.

(2) If the upper boundary be a parabola, an exact result will be obtained by bisecting the base line, and then

$$A=\frac{h}{3}\left(y_1+y_3+4y_2\right),$$

where h is half the base line.

This is Simpson's well-known rule: If any odd number of ordinates be taken, say 7, it is considered as a succession of three areas bounded above by three parabolas, *i.e.* the area from y_1 to y_3 is added to the area from y_3 to y_5, and this, again, is added to the area from y_5 to y_7. The formula used is then

$$A=\frac{h}{3}\left[y_1+y_7+2\,\overline{y_3+y_5}+4\,\overline{y_2+y_4+y_6}\right].$$

If m denote the number of additional areas computed by this method, the general formula will take the form

$$A=\frac{h}{3}\left[y_1+\overline{y_{3+2m}}+2\,y_{1+2m}+4\,\overline{y_2+y_{2+2m}}\right].$$

It should be especially noted that this formula must be used only when the number n of ordinates is odd and the number of intervals even. In the second and third terms the values 1, 2, 3, etc., are assigned successively to the symbol m, ending with that value of m which denotes the number of additional areas that are to be computed. The formula is based on the assumption that $y=a+bx+cx^2$, and gives the best possible approximation to the true area if only three ordinates are given.

(3) If, however, four ordinates be given, we may assume that $y=a+bx+cx^2+dx^3$, and the resulting formula based on this assumption,

$$A=\frac{3h}{8}\left[\overline{y_1+y_4}+3\,\overline{y_2+y_3}\right],$$

will give the best possible approximation if only four ordinates are given. This formula should be used only when the number of ordinates is $4+3m$, and it then becomes

$$A=\frac{3h}{8}\left[\overline{y_1+y_{4+3m}}+2\,y_{1+3m}+3\,\overline{y_2+y_3+y_{2+3m}+y_{3+3m}}\right].$$

(4) If five ordinates be given, we shall obtain a more accurate result by assuming that y is a quartic function of x, and for 5, 9, 13, or $5+4m$ ordinates the following formula may be used:

$$A=\frac{2h}{45}\left[7\,\overline{y_1+y_{5+4m}}+14\,y_{1+4m}+12\,y_3+y_{3+4m}+32\,\overline{y_2+y_4+y_{2+4m}+y_{4+4m}}\right].$$

(5) Similarly, if $6+5m$ ordinates be given, y may be regarded as a quintic function of x, and the formula becomes

$$A=\frac{5h}{288}\left[19\,\overline{y_1+y_{6+5m}}+38\,y_{1+5m}+75\,\overline{y_2+y_5+y_{2+5m}+y_{5+5m}}+50\,\overline{y_3+y_4+y_{3+5m}+y_{4+5m}}\right].$$

(6) Again, if $7+6m$ ordinates be given, y may be assumed to be a sextic function of x, and we then have the formula

$$A=\frac{h}{140}\left[41\,\overline{y_1+y_{7+6m}}+82\,y_{1+6m}+216\,\overline{y_2+y_6+y_{2+6m}+y_{6+6m}}+27\,\overline{y_3+y_5+y_{3+6m}+y_{5+6m}}+272\,\overline{y_4+y_{4+6m}}\right].$$

In all these formulæ the first term consists of the sum of the first and the last ordinate. In (2), (3), (4), (5), and (6) the values 1, 2, 3, etc., are assigned successively to the symbol m in the following terms according to the number of ordinates. Thus if in (6) nineteen ordinates are given, $19=7+6m$, so $m=2$.

When $m=0$, the ordinates with m as a part of their subscript are omitted in all but the first term.

Example.—Suppose the base line be divided into six equal intervals ($h=\frac{1}{6}$), and the value of the ordinates be

$y_1=0$	$y_5=0.5527708$
$y_3=0.7453560$	$y_4=0.8660254$
$y_5=0.9428090$	$y_6=0.9860133$
$y_7=1$	

As seven ordinates are given, we may use any one of the rules (6), (3) which is adapted to $4+3m$ ordinates, and (2) which can be used when $3+2m$ ordinates are employed. We should expect to get a more accurate result when the higher-order formula is employed, and this we shall find to be correct. The values given refer to the quadrant of a circle, so that the true value is $\pi/4$, or 0.78539816 . . .

By method (6), putting $m=0$, the result is 0.7791866, *i.e.* 0.7972 per cent. too small.

By method (3) the result is 0.7758061, or 1.342 per cent. too small.

By method (2) the result is 0.777531, or 1.063 per cent. too small.

This result is curious, and shows that a small arc of a circle approaches more nearly to a small arc of a parabola than to a small arc of any cubic curve, but it will be noted that method (6) gives a much more accurate result.

We may, however, use a combination of the above rules; for instance, we may take five ordinates by rule (4) and the remaining two intervals by rule (2). As the first three ordinates increase more rapidly than the last three, we should naturally leave the last three to be dealt with by rule (2). In this way a result of 0.7784954, or a defect of 0.0069027, or an error of only 0.88667 per cent. is obtained. Had we reversed the order and used Simpson's rule for the first two intervals, the defect would have been 0.0078447, or an error of 1.0102 per cent.

In conclusion, it may be stated that if the nature of the curve is unknown a more accurate result will always be obtained by using the highest-order formula that can be used with the given number of ordinates. If two different formulæ are used, it has just been shown that the most accurate result is obtained when the higher-order formula is used for that part of the curve in which the variation of the ordinates is the greater. If the curve be a parabola, an absolutely accurate result is obtained by using only three ordinates by means of method (2).

It may be thought that plotting the curve and estimating its area mechanically by means of a planimeter will be always the best and speediest method to adopt, but this is by no means the case. It often takes far less time to calculate, say, thirteen ordinates and to use method (6) than to trace the curve.

A. S. PERCIVAL.

Westward, Newcastle-upon-Tyne.

An Electronic Theory of Isomerism.

THE interesting suggestions made by Mr. W. E. Garner in NATURE for February 19 with regard to a possible explanation of the isomerism of certain organic compounds may be examined from a different, but perhaps simpler, point of view by employing the "ring electron" or "magneton" of Mr. A. L. Parson. The electron is looked upon as a circular anchor ring of negative electricity rotating about its axis at a high speed, and therefore behaving like a small magnet. In connection with atomic and molecular numbers I have directed attention elsewhere to the "rule of eight," according to which a difference of 8 or a multiple of 8 is frequently found between the numbers of the unit electric charges associated with analogous atoms or molecules. In the theory of the "cubical atom" put forward by Prof. Gilbert N. Lewis and developed by Dr. Irving Langmuir, one of the most stable configurations for the atomic shell is that in which eight electrons are held at the corners of a cube. The single bond commonly used in graphical formulæ involves two electrons held in common by two atoms (Fig. 1); the double bond implies that four electrons are held conjointly by two atoms (Fig. 2) Or if the *pair* of electrons be regarded as the most stable grouping of all, it may be, as Lewis and Langmuir suggest, that the pairs of electrons held in common by two atoms are drawn closer

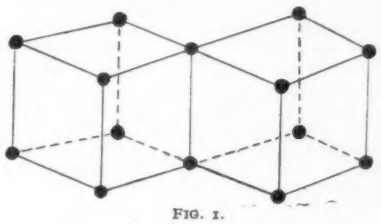

FIG. 1.

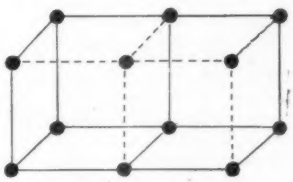

FIG. 2.

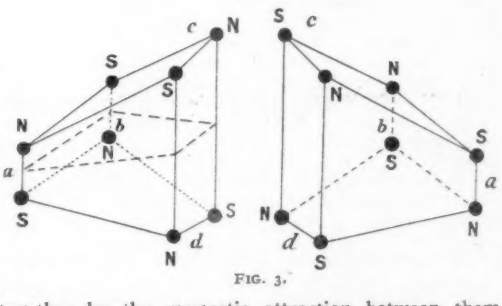

FIG. 3.

together by the magnetic attraction between them. Dextro- and lævo-rotatory forms of a compound might then be represented as mirror images as in Fig. 3. The letters N and S in this diagram may be taken to represent the polarity of the external face of the ring electron.

Mr. Garner suggests the possibility of the existence of a large number of optical isomerides amongst organic compounds, but the view here put forward does not lead to that conclusion; on the contrary, it seems to give exactly the same number of isomerides as the ordinary structural formulæ. It is true that it is possible to reverse *in the diagram* the magnetic polarity of one or more pairs of electrons, but even if the arrangements so obtained were stable, it is doubtful whether they would represent different isomerides. It would not be possible to explain the phenomenon of free mobility about a single bond

which is assumed in stereo-chemistry if such a reversal of the magnetic axis were accompanied by a change in the nature of the compound. Such modifications, however, might conceivably account for mutarotation. It was thought that in the case of a double bond, such as exists in cinnamic acid, it might be possible to have a larger number of isomerides than would be given by the ordinary theory, but a close examination of the structural formulæ based on the cubical atom has shown that (subject to the limitation already referred to) this is not so.

The view here suggested appears to afford an adequate basis for a theory of optical activity. Such activity arises from a difference effect, and can be manifested only when there is lack of compensation amongst the electrons associated with the various parts of the molecule. If the chemical bond is to be attributed to a *pair* of electrons, it is easy to understand how such compensation can be brought about in the great majority of chemical compounds. In the case of a single asymmetric carbon atom, the symmetrical arrangement of each of the four electron pairs is disturbed by the presence of the adjacent groups, resulting in only partial compensation. Thus in the compound C *a b c d*, the pair of electrons associated with group *a* is under the influence of the unlike groups *c* and *d*, and, therefore, cannot be symmetrical. But if *c* and *d* are made alike, the whole molecule will have a plane of symmetry indicated by the broken line in the left half of Fig. 3. Thus the molecule will be inactive through "internal compensation" with respect to the electrons which form the outer shell of the carbon atom. I may add that the ring electron, constrained to move backwards and forwards along its linear axis, is admirably adapted to replace the ordinary electron moving backwards and forwards along a spiral path postulated in Drude's theory of rotatory liquids.

It may be permissible in this connection to emphasise the remarkable success that has attended Langmuir's development of the "octet" theory, by means of which it is possible to predicate the physical and chemical qualities of a substance, and even its crystalline structure. Langmuir states that the theory seems to explain all the cases of stereo-isomerism with which he is familiar. "For example, in the amine oxides, $NR_1R_2R_3O$, nitrogen is quadricovalent, so that these substances exist as optical isomers, just as in the case of a carbon atom attached to four different groups." Such a compound is, in fact, represented by the diagram already given. H. S. ALLEN.

The University, Edinburgh, March 2.

The Principle of Equivalence and the Notion of Force.

I SHALL be grateful to be permitted to make an inquiry in connection with the principle of equivalence through the medium of the columns of NATURE.

In the recent forms of the theory of relativity it has been asserted that in the neighbourhood of matter we may alternatively conceive the existence either of a field of gravitational force or of a distortion in the space-time continuum, the two conceptions being equivalent. The point then arises, however, as to whether, in arranging the body of ideas and propositions constituting physical science in logical sequence, the idea of force (at any rate, "force" in the sense of "action at a distance") or that of distorted space-time should be regarded as logically prior. The possibility of adopting the idea of distorted space-time as prior, and hence of finally dispensing with the notion of force from the physical scheme, evidently depends on a further generalisation of the principle of equivalence. For a difficulty seems to arise in connection with other forms of action at a distance, such as the forces in a magnetic or an electrostatic field. Apparently we cannot regard these as equivalent to a space-time distortion, for they lack the universality of gravitation, seeing that only bodies of specific types of material are deflected by them.

I should therefore like to ask two questions:

(1) Is it possible to extend the principle of equivalence in any way so as to include *all* forms of action at a distance?

(2) If not, is there anything gained, even from a purely logical point of view, by discarding the notion of gravitational force while we are still unable to discard *by the same method* the notion of certain other forces which in many respects exhibit a close analogy to gravitation? C. A. RICHARDSON.

4 The Crescent, St. Bees, Cumberland,
March 1.

Expenses of Scientific Work.

A JOINT committee of the British Association of Chemists, the Institute of Chemistry, and the National Union of Scientific Workers is putting forward the claim that the following expenses should be allowed as a charge against income in arriving at the assessment of those who earn their living either by purely scientific pursuits or by the application of science to industry:—

(1) Subscriptions to scientific and technical societies and libraries, and to scientific and technical periodicals.

(2) Purchase and renewal of scientific and technical books, instruments, apparatus, chemicals, and other materials.

(3) Rent and expenses of study or laboratory.

(4) Travelling and other expenses incurred in attending scientific meetings.

(5) Provision of special clothing for work and renewal of clothes damaged in the course of employment.

(6) Other expenses incurred in the course of research.

A form of memorial to be presented to the Lords of the Treasury is being sent to all bodies representative of scientific workers for their consideration and support.

Some claims for abatements under the above headings have already been made by individuals with varying success. I should be grateful for any information available in support of the petition.

A. G. CHURCH,
Secretary.

National Union of Scientific Workers,
19 Tothill Street, Westminster,
London, S.W.1, March 15.

Scientific Reunions at the Natural History Museum.

I WRITE to correct a small error that has crept into the note on the meeting of the International Council for the Exploration of the Sea which appeared in NATURE for March 11. When the members of that council visited the Natural History Museum on March 2 they were entertained, not by the Trustees, but by the Staff Association, the occasion being a scientific reunion, as was, indeed, stated in a later note in the same issue. I may add that these reunions are held with the approval and permission of the Trustees. G. F. HERBERT SMITH,
Hon. Secretary.

Natural History Museum Staff Association.

The World's Production of Silver.

THE recent action of the Chancellor of the Exchequer in introducing a Bill into the House of Commons for the purpose of debasing the silver currency from 925 to 500 parts per 1000 has directed public attention to the acute shortage of silver which exists. This action is unavoidable if a silver currency is to be maintained, since the price of the metal has risen so much that coins are no longer tokens. They are, in fact, worth to-day considerably more than their face value, and there is, accordingly, a temptation to melt them down and sell them for the considerable profit that the transaction would bring in. Such a procedure is, of course, illegal. In the years preceding the war the market price of silver, while subject to fluctuations, was never far from 2*s*. per "standard ounce." This expression is rather unfortunate, since it is not the ounce that is standard, but the quality of the metal. Its real meaning is a troy ounce of silver alloy containing 92·5 per cent. of the metal. With standard silver at about 5*s*. 6*d*. per ounce, the coins reach parity. During recent weeks the market price has fluctuated between 7*s*. and 7*s*. 5*d*. per ounce, though it is true that a remarkable fall of 6⅛ in the price took place on March 5, and a further fall of 5⅛ on March 11, owing largely to the improvement in the exchange with the United States of America. As stated, however, the Chancellor's action is necessary, since the minting of silver coins is possible only at a heavy loss. Nevertheless, this Bill was opposed in the House, although the opposition was not carried to a division.

It so happens that in January this year the report and appendices of the Committee appointed by the Secretary of State for India to inquire into Indian exchange and currency were published and presented to Parliament. In vol. iii. will be found appendix xxx., which contains a report on the world's production of silver.[1] This is the work of Prof. C. Gilbert Cullis and Prof. H. C. H. Carpenter, who at the request of the Secretary of State for India undertook an inquiry more than a year ago into the output of silver during recent years in the various silver-producing countries; the prospects, so far as they could be estimated, of future output; and the causes by which it is likely to be influenced. Their report covers some sixty foolscap pages. The subject-matter is presented in five main sections dealing severally with the raw materials from which silver is obtained, the location and quantitative importance of centres where silver-bearing ores are mined, the processes involved in the extraction of the metal, the distribution and relative importance of the centres where refining is carried out, and the conclusions affecting the supplies and price of the metal.

It appears from this report that in 1860 the world's production of "fine"—*i.e.* pure—silver was 30 million ounces. With some fluctuations this increased steadily until 1912, when the output was 233 million ounces, or nearly eight times that of more than half a century earlier. From that date, although a continuance of the upward trend was to be expected, a decline in production set in and continued down to the end of 1917, which was the last year for which complete figures are available. It is clear from the report that this reduction in output is assignable not to any sudden failure of the world's resources, but to an interruption in the winning of them.

The main source of the supply of silver ore is the American Continent, which in 1912 produced 82·5 per cent. of the total output. Approximately three-quarters came from North America and Mexico, the former furnishing 42 per cent. and the latter 32 per cent. Mexico was the largest single producer. A decrease in Canadian production had set in shortly before this, due to the progressive exhaustion of the Cobalt mines, but this was more than compensated by an increase in the production of the United States. The key to the shortage of the world's supplies is to be found in Mexico, where, owing to a series of political revolutions, the production fell from an average of close upon 74 million fine ounces for the years 1910–13 to an average of little more than 30½ million fine ounces for the years 1914–17, a reduction of some 43½ million out of a total reduction of 50½ million ounces in the world's output.

This serious diminution in the supply came at a time when, owing to the withdrawal of gold from circulation on account of the war, there was an unusually keen demand for silver, particularly for coinage purposes. The report of the Currency Committee points out that the coinage of the British Empire absorbed nearly 108 million ounces of fine silver in the years 1915–18, as against 30½ million ounces in the years 1910–13, and there is evidence that there have been similar increases in the coinage of other countries. Moreover, whereas China from 1914–17 was a seller of silver, and her net exports amounted to more than 77 million ounces, she has since become a persistent buyer, and the recent remarkable rise in the price of the metal is due to her purchases. India has for many years been a heavy buyer of the metal, and in times of normal trade was the largest importer of this commodity. War conditions have accentuated this, and in the three fiscal years April, 1916, to March, 1919, purchases for the purpose of liquidating trade balances amounted to more than 500 million ounces, which was probably very nearly the entire world's production for the period. These have been the chief (but not the only) factors in raising the price of silver to its extraordinary level.

It is clearly seen from the report that silver is mainly obtained as a by-product from mines which are worked for some other metal or metals.

[1] Vol. iii., Appendices to the Report of the Committee appointed by the Secretary of State for India to inquire into Indian Exchange and Currency. No. xxx., "Report on the World's Production of Silver." By Prof. H. C. H. Carpenter and Prof. C. Gilbert Cullis. Pp. 182–241.

Relatively few properties are worked solely or even mainly for silver, and only a small proportion of the world's supply has of late years been derived from them. It is therefore essentially a by-product. The more important economic metals with which it is most commonly associated are gold, copper, lead, and zinc. These five metals tend to be gregarious, and many deposits contain all of them. It is also found with tin, as in Bolivia, and with nickel and cobalt, as in Ontario, but such cases are uncommon. Although in different regions or in different parts of the same region the above five metals are found in a great variety of combinations, certain of these are particularly common. Thus gold and silver almost invariably occur together either with or without base metals. Again, lead and zinc nearly always accompany each other, and ores carrying these two metals, notably those in which lead predominates, are often richly argentiferous, the lead and silver forming an especially characteristic association. Copper in like manner is usually accompanied by small quantities of gold or of both gold and silver. The presence or absence of base metals in silver-yielding ores is of particular importance, since it determines the existing diversity in their metallurgical treatment and occasions their classification into two groups, known respectively as "milling ores" and "smelting ores," the former signifying those in which the values are entirely or mainly in precious metal. From the figures quoted in the report, it appears that, broadly speaking, about two-thirds of the world's supply of silver in 1912 was obtained from base metal, and one-third from precious metal, ores. Further, only one-fifth was obtained from mines worked exclusively for silver, while four-fifths was derived as a by-product from mines which were worked primarily for one or more of the metals—gold, copper, lead, and zinc—and would not have been in operation if their silver had been the only metal present. Formerly, the precious metal ores were the more important source of supply, but in the last few decades more and more of the metal has been won from base metal ores. It will be seen, therefore, that the authors, in endeavouring to estimate the future production of silver, have been forced to take into consideration the mining and metallurgy of four other important metals as well.

It is stated in the report that in 1912 the New World—*i.e.* the American Continent—furnished 82·5 per cent., and the Old World only 17·5 per cent., of the mine production of silver. The output in the British Empire was 21·7 per cent. Mexico led with 32·0 per cent., followed closely by the United States with 28·3 per cent. Towards the production of refined silver the New World contributed 73·0 per cent., and the Old World 27·0 per cent., the contribution of the British Empire being 18·2 per cent. The interesting fact emerges that the United States of America refined just about one-half the world's silver (49·6 per cent.), whereas Mexico refined only 14·2 per cent. More than half the Mexican mine production was refined in the U.S.A., and very nearly the same proportion of the Canadian output. It will be seen, therefore, that the position now held by the U.S.A., as the chief source of supplies of refined silver, is one of considerable importance. The same is true to an even greater extent for the metals copper and zinc.

The authors' view of the future is that if normal industrial conditions are restored in regions of curtailed production, a silver output at least as great as any yet attained may reasonably be anticipated. If, however, conditions affecting industry in general, and mining and metallurgical industries in particular, do not become favourable in these regions, a long period must elapse before the world's output can return to the previous high-water level, and a still longer one before the advance beyond that level interrupted since 1912 can be resumed. So long as the political conditions remain unsettled in Mexico, supplies from that country will continue to be small. This is particularly serious, because of the large dimensions of the normal Mexican output.

With the demand for silver more urgent than any previously experienced, the restoring of the mines and mills of Mexico to unhampered production has become a matter of pressing international importance. It must be borne in mind, however, that any extension in the mining of precious metal ores will take time, and that the mining of base metal ores is for the moment below normal, and will continue so as long as the surplus supplies of copper, lead, and zinc produced during the war remain unabsorbed. Silver production will probably, therefore, remain for a time at a low level. When, however, increased precious metal mining reaches the production stage, and the temporary check to base metal mining has been removed, the authors anticipate a steady increase in the output of the metal.

It is well to remember that, although silver has long occupied an important position as "second string" among metals suitable for currency, there are important industrial demands for it for other purposes. It is only necessary to mention two of these. First, in addition to the mechanical properties which make it valuable as a currency metal, there are others which have long been known and utilised in the silversmith's art. Standard silver lends itself readily to rolling, stamping, spinning, and mechanical operations employed in the manipulation of the metal in the arts, and upon them important industries giving employment to many workers are based. Secondly, the well-known sensitiveness of silver salts to light, made use of in photography, is being increasingly utilised in the "moving picture" industry, which in recent years has absorbed a considerable proportion of the total output of the metal. Both these industries are formidable competitors for silver produced to-day, and they will have to be reckoned with by future Chancellors of the Exchequer.

Time-reckoning of the North American Indians.

UNDER the title, "Calendars of the Indians North of Mexico" (University of California Publications in American Archæology and Ethnology, vol. xvi., No. 4), Miss Leona Cope has collected and arranged a large amount of information dealing with the divisions of time in use among the Indians of North America, including much linguistic material. The term "calendar" must be taken in a very elastic sense, for the Indian's power of keeping account of an interval of time is usually limited to two or three years, and never went so far, apparently, as even to fix the number of days in a month. The only general rule seems to be a complete absence of uniformity, variations of system being found even among the most closely related groups. The basic period is naturally the lunation, indicated by an expression which is related etymologically, without exception, to the moon, and reckoned generally from new moon, but in some cases from full moon. The month is sometimes divided into "weeks" roughly depending on the lunar phases, but very variable in length and number. In general, the seasons are vaguely marked periods not directly connected with the months, though the latter are sometimes divided into a summer and a winter series. When the wide range of latitude in the area is considered, a corresponding variety of practice is natural enough. Thus it is not surprising that the Greenland Eskimo find a convenient division of the day in the ebb and flow of the tides, or that a Point Barrow Eskimo should say that there are nine "moons," and after that no moon, but the sun only. But the variations within connected groups make the study a complicated one.

This appears especially in the attempts to connect the series of months with the year. For the most part, covering the whole of the eastern and central region, there is no astronomical foundation. There is no uniformity in the time of beginning the year. In general, twelve months are recognised and are designated by purely descriptive names associated with some seasonal event. Some tribes have thirteen or even more months, but the mode of adjustment is quite crude, a month being sometimes intercalated or omitted only when a palpable discrepancy with the seasons shows the need. Only in the south-west, along the Pacific coast, and among the Eskimo of the far north is an astronomical element introduced. This takes the form of observing the winter solstice; the equinoxes, if recognised, are never used for the purpose. A particular variation in the naming of the months takes a numerical form. This occurs on the Alaskan coast and further south; only two tribes have a complete system of this kind, while a third is unique in combining numbered months with a solstitial basis. Ritual ceremonies are also represented in the names of the months among western tribes. Apparently, the Kaniagmiut Eskimo are alone in naming months from the rising of the Pleiades or Orion. Altogether the astronomical element in this complex subject is small, and the present memoir, which contains three maps representing the regional distribution of different types or systems, has its chief interest on the linguistic side and as a study of primitive culture.

Obituary.

DR. CHARLES GORDON HEWITT.

THE premature death of Dr. Charles Gordon Hewitt, Dominion Entomologist of Canada, who succumbed to an attack of pneumonia, following influenza, on February 29, is a serious loss to biological science. To an aptitude for field observation cultivated from his earliest youth, Dr. Hewitt added knowledge and skill in the latest laboratory methods. While eagerly devoting attention to the numerous economic problems which came before him, he always appreciated the necessity for constant purely scientific research. He worked, indeed, in the most favourable circumstances, and made the best use of his opportunities.

Born near Macclesfield in 1885, Dr. Hewitt passed from the local grammar school with a scholarship to the University of Manchester. After graduating with honours in zoology, he was appointed assistant demonstrator in that science, and when a new department of economic zoology was founded at Manchester, he became the first lecturer. During this period he hired a greenhouse and made an exhaustive study of the life-history of the house-fly, which formed the subject of his thesis for the doctorate. He was a pioneer in such work in this country, and his general results were eventually published in the form of a Cambridge manual. At the same time he undertook researches on the large larch saw-fly, which was ravaging the plantations of the Manchester Corporation round Thirlmere. He was also interested in the feeding habits of certain insectivorous birds.

In 1909 Dr. Hewitt was appointed entomologist to the Dominion of Canada, and at once began to organise laboratory work on the lines which he had already proved successful. He also paid much attention to the improvement of the law relating to injurious insects. Gradually his interests widened, until in 1917 he increased his responsibilities by accepting the post of consulting zoologist to the Canadian Commission of Conservation. He took an active part in the work of the Commission, and contributed several papers on the protection of mammals and birds

to its annual reports. His advice was duly appreciated and considered in framing legislation.

Dr. Hewitt was a corresponding member of the Zoological Society of London, and he received the gold medal of the Royal Society for the Protection of Birds.

By the death of SIR ROBERT MORANT at the early age of fifty-seven the Civil Service loses one of its ablest and most remarkable members. His great powers of organisation found full scope for their exercise when he was, in 1902, appointed Secretary of the recently created Board of Education. The appointment was well merited, for it was to his indefatigable industry in supplying material, to his skill in dealing with details, and to his ingenuity in overcoming difficulties that the Education Bill of 1902 was safely carried through Parliament. As permanent head of the Board of Education his restless energy and ceaseless activity bore down all opposition, and made him ready at all costs to carry out his own ideas. Organisation was indeed with him a ruling passion, and the smooth working of a complicated machine tended to become more important than the purpose the machine was intended to serve. During the ten years that he held the post of Secretary he served under five different Presidents, and the rapid succession of his temporary chiefs was not altogether unconnected with his own remarkable tenacity of purpose and skill in carrying it into effect. While his undoubted talents and magnificent powers of work have thus left their mark on the educational system of the country, it still remains to be seen if the vast and expensive machinery he called into existence will be more of a help than a hindrance in the development of our national education. In 1912, on the appointment of Mr. J. A. Pease as President of the Board of Education, Sir Robert Morant was promoted to the chairmanship of the English Commission formed under the National Health Insurance Act. He lived to see the early opposition to this Act gradually die away, and the Act itself become part of a great scheme of health legislation. To this Commission he devoted the same power of organisation and intensity of effort, and his early death is probably largely owing to his unsparing use of these great talents in the public service.—C. A. B.

THE death is announced of the veteran Italian botanist, DR. PIER ANDREA SACCARDO, emeritus professor in the Royal University of Padua. Born at Treviso in 1845, Prof. Saccardo joined the Royal Botanic Garden of Padua in 1866 as assistant director, and in 1878 became director—a post which he retained for the remainder of his official life. He was also professor of botany in the Royal University. He is best known for his systematic work on the fungi; his "Sylloge Fungorum omnium hucusque cognitorum" has been, since the publication of vol. i. in 1882, the working handbook of systematic mycology. Succeeding parts or volumes appeared at intervals, the last, vol. xxii., in 1913; other eminent mycologists have co-operated in this great work. Prof. Saccardo also published numerous separate memoirs dealing with the fungi. His "Notæ Mycologicæ" was a series of descriptive papers in various journals devoted to mycology from 1890 to 1916, when series xx. appeared in the *Nuovo Giornale Botanico Italiano*. But his activities were not limited to the fungi. Under the title "La Botanica in Italia" (1895, 1901), an exhaustive compendium of Italian botanists and their work from the Roman epoch onwards, he made a valuable contribution to botanical bibliography. In 1909 he contributed a supplemental volume to the "Flora analitica d'Italia" (by Fiori, Paoletti, and Béguinot), entitled "Cronologia della Flora Italia," a systematic list of the earlier records of the species of ferns and flowering plants, native or naturalised in Italy. Prof. Saccardo was also the author of a pamphlet, "Chromotaxia," on colour nomenclature, for the use of botanists and zoologists. In recognition of his eminent services to botany he was elected in 1916 a foreign member of our own Linnean Society.

WE regret to note that *Engineering* for March 5 records the death of MR. WILLIAM RICHARDS WILLIAMS on February 23. Mr. Williams studied engineering at the Royal Engineering College, Coopers Hill, and was appointed in 1887 assistant engineer to the Public Works Department by H.M. Secretary of State for India. His work in India was chiefly connected with irrigation. In 1901 he was appointed to the Irrigation Service in Egypt, and ultimately became Inspector-General of Irrigation, Lower Egypt. Mr. Williams had been a member of the Institution of Civil Engineers since 1906.

WE have received from Dr. Angel Gallardo, now president of the Argentine National Council of Education, a copy of his obituary notice of DR. F. P. MORENO in *El Monitor de la Educación Común* (Buenos Aires, December 31, 1919). Dr. Gallardo gives some account of Dr. Moreno's later work for education, to which we briefly referred in NATURE for January 15, and emphasises especially the importance of his efforts to provide for the children of the poorer classes. Among other institutions, Dr. Moreno established the Boy Scouts in Argentina. The notice is accompanied by an excellent portrait, which is, however, a little blurred in the printing.

WE much regret to see the announcement of the death, on March 13, in his seventy-eighth year, of PROF. CHARLES LAPWORTH, for many years professor of geology and physiography in the University of Birmingham.

The Gyrostatic Compass.

By S. G. BROWN, F.R.S.[1]

I HAVE directed attention to several faults that have to be rectified if the compass is to be of use on a ship, and I shall now discuss the last, but by no means the least, of the errors that may arise if the instrument is not properly designed. This error was not known when the gyro-compass was first brought out, and it proved a most difficult fault to correct, while its elimination has had more to do with the design of the later forms of gyro-compass than any other factor.

If a gyro-wheel is precessed towards, and kept pointing to, the north by an ordinary pendulum weight, it will work well on board ship provided that the ship is steaming on a fairly smooth sea; but if the direction of the ship points anywhere in the quadrants—that is, north-west or north-east, south-west or south-east—and the ship rolls, the wheel will try to set itself so as to bring the rim of the spinning wheel in line with the roll; and in a long-continued and heavy roll the compass may show an error of 30° or more—a most serious fault, and one that would render the instrument quite useless in a heavy sea. This error is called the "quadrantal error." The extent of the error depends upon the violence of the ship's rolling and the direction of the axis of the wheel. If the ship points direct north, south, east, or west, the error is nothing, but it would be a maximum in any of the directions before mentioned.

I think Anschutz was the first to point out the error and suggest a cure. This I gather from one of his publications in the year 1911, in which, speaking of the tendency of the compass to wander when on board ship, he says:—"Theoretically, the influence of rhythmic turning movements on a gyroscopic apparatus must disappear completely if not only the real, but also the apparent, movements of inertia of the movable system become equal for each plane."

If we go back again and study our simple gyro-compass, we see that the movable system is not symmetrical. In the direction of the axis of the wheel the effect of tilting movement is more or less resisted by the spinning wheel—this may be termed the stabilised direction; while at right angles to this—that is, in the direction of the rim of the wheel—there is no resistance to tilting encountered, and this direction we term the direction of free swing. A simple form of gyro-compass pointing, therefore, in a direction, say, north-west on board a rolling ship has a force applied to it tending to turn it so as to bring its direction of free swing into line with the roll.

Anschutz gets rid of the error by multiplying the number of his gyro-wheels and by making the instrument as symmetrical as possible. In England the quadrantal error was first discovered and studied, I believe, by the Admiralty Compass Department. In the year 1914 the Sperry Co. claimed to have effected a cure for the error by attaching the pendulous weight, not directly to the gyro casing, but through a pin arranged to move in a slot in the casing. In order that the axis of suspension of the pendulum may remain vertical when the compass oscillates with the rolling of the ship, a small auxiliary gyro was employed to stabilise the pin connection between the pendulum and the gyro casing.

We therefore see in these applications of Anschutz and Sperry two general ideas. In the first case the idea is to make everything symmetrical, like a ball, so that there is no stabilised or free swing direction to the wheel, and, therefore, no tendency to turn; while in the second a method is provided to prevent the point of application of the pendulum weight from moving and acting as a crank, and, by keeping the pendulum weight always vertical in the north-west direction, to destroy its power of turning the compass. In the Brown compass the quadrantal error is eliminated by making the weight operate completely out of phase with the roll—that is, at 90° displacement.

If a gyro-compass is worked by a weight which tends to precess the wheel in phase with the roll, then there must be a quadrantal error, but there will be no error if it is forced to operate completely out of phase with it. It is also essential, as Anschutz has remarked, that the real moments of inertia shall be the same in all directions of the movable system of the compass; that is to say, the moving system should be in dynamic balance, as it is termed.

If a child's hoop is suspended by a string and is swinging in one direction, the hoop tends to set itself lengthwise to the direction of the swing. On the other hand, if an exactly similar hoop be placed over, but at right angles to, the first, and suspended as before, then on swinging the hoops there will be no tendency for them to turn, as they are now in dynamic balance. It is for this reason that the mass distribution of the moving system of the gyro-compass should be in dynamic balance, and to carry this out adjustable weights are fitted, usually in the direction of the spindle of the wheel, to counteract the weight of the supporting ring of the gyro casing, and thus there is no tendency for the compass to turn, due to this cause, when under the action of rolling.

The Brown gyro-compass is shown diagrammatically in Fig. 4. A is the gyro-wheel in its casing B. This case is carried on knife-edges M in the vertical ring F, and is thus free to tilt under the action of the rotation of the earth. The vertical ring turns in azimuth on a frictionless mounting, consisting of an oil-pump at the bottom and a ball-bearing, *m*, at the top. XY is the three-phase motor that drives the oil-pump.

The gyro-wheel is the rotor of a three-phase motor, and current is led into the moving system through the three sets of iron contact rings R and S. These rings do not touch, but the outer set are hollow, and mercury fills the space between them, so that there is little friction. The vertical ring is dynamically balanced by two projecting weights D. Q is the pendulous mounting, supported by gymbal rings and by the outer row of springs to take up shock.

The gyro-wheel runs at 15,000 revolutions per minute, and thus acts as a powerful blower, giving an air-pressure equal to some 3 in. of water. Fixed to the vertical ring, but connected through the hollow bearing M to the inside of the case, is the air-jet L. This jet blows into the two halves of the air-box K, and thence through the pipes I; the air-pressure is thus transmitted to the oil in the two sets of bottles C and D. H is another air-jet similarly mounted, and employed to act upon a pair of contact-making vanes I.

The contacts I, through the agency of the controller, which is fixed on the switchboard, are to work the repeaters and the step-by-step motor V; this motor forces round the follow-up ring N to keep the contact-making vanes I always opposite the air-jet, and in doing this all the repeaters on the ship follow suit. U is the compass card fixed to the upper por-

[1] Discourse delivered at the Royal Institution on Friday, January 30. Continued from p. 48.

tion of the vertical ring, and O the lubber-line support.

By removing the four screws marked *n* the gyro-compass can be completely removed from the gymbal rings. The instrument thus removed is shown in Fig. 5.

To explain the action of the oil bottles I have introduced Figs. 6 and 7.

Fig. 2 illustrates the simplest form of compass, in which the wheel and case B are controlled by the pendulous weight W. When the case tilts, as shown, W is moved to one side of the vertical support, and the weight tries to bring the case again to the horizontal.

Suppose the wheel revolves in the direction of the arrow *a*, the righting torque is in the direction of the arrow *b*; then the wheel and case will turn in azimuth in the direction of the arrow *e*. Such a compass would have a quadrantal error, because the weight W would produce stresses in phase with the roll.

Fig. 6 illustrates the method of control of the Brown compass. When the case B is horizontal the bottles E, E are half-full of oil, and the air-jet L is blowing equally into the two halves of the air-box K; but when the case tilts, as shown, then the air-pressure blows into one side of the box more than into the other, and in such a direction as to force the oil from the lower bottle into the one raised. There is, therefore, a considerable righting torque indicated by the weight of the oil W trying to restore the case back again to the horizontal.

When the pendulum swings under the action of the rolls of the ship, the air-jet L moves from one side to the other of the air-box in tune with the roll, blowing the oil periodically from one bottle to the other. At the middle of swing of the pendulum the air-jet is at the middle of the air-box, and there is no difference of air-pressure, and, therefore, no movement of the oil; and when the swing is at the end of its path, and not moving, the air-jet is at one side of the air-box and producing the maximum movement in the oil; it will therefore be seen that the movement of the pendulum and that of the oil are out of phase with each other. It is for this reason, given good dynamic balance, that there is no quadrantal error whatsoever with this method of control.

Fig. 7 illustrates the method of damping the compass. Fixed to the same air-box K are the two damping bottles C, C, smaller than E, E, but the air here acts in the opposite direction to that in Fig. 6.

In one of these damping bottles is the adjustable needle-valve, and this valve has a constricted passage,

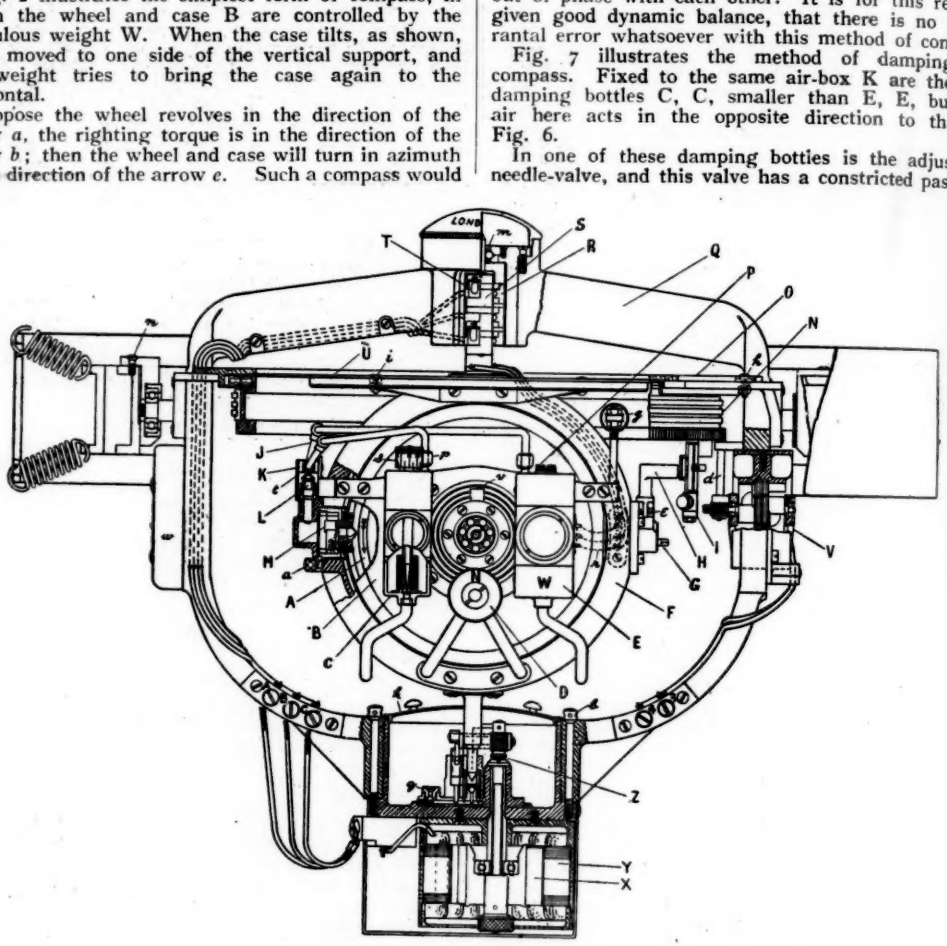

FIG. 4.

and thus the flow of oil from one bottle to the other is suitably retarded.

As regards the accuracy of the compass, I may mention that one on board a flagship in the North Sea during the war was observed with particular care, especially during very heavy weather, and it was reported that it was never more than 1½° from the true north position during the whole of the tests.

Trials on a commercial ship have demonstrated the fact that the employment of a gyro-compass resulted in the ship steaming every day more than 3 per cent. greater mileage; in other words, one day's steaming in thirty would be saved, resulting in a proportionate saving in coal and all other expenses.

I come now to a most important application of the gyro-compass, namely, its employment as a gun director.

The use of the gyrostat in the Whitehead torpedo has revolutionised naval strategy, and I believe the use of the same instrument in the form of a gyro-compass gun director may possibly produce profound changes in gunnery practice in the future.

Modern naval warfare is entirely different from that of the past in the fact that the rival fleets come into action when separated by many miles; the guns have, therefore, to be worked and fired while the distant targets are invisible to the gunners.

The guns have to be directed by observers in an elevated position, these observers communicating the distance of the target and its direction in space.

The direction in space must be supplied by a gyro-compass on board the ship, and it is essential that the compass for this purpose should be of extreme accuracy.

Once the guns are properly trained, they may be joined up and controlled by the gyro-compass, and for this purpose the turrets would be designed to act as huge repeaters, keeping the guns pointing on the target, changing only on receiving new directions from the observer.

The compass would hold the guns pointing on the distant target quite independently of the movements of the ship, which may at the time be steaming at full speed and manœuvring. Such movements are a great protection to ships against submarine and aerial attack.

It has been suggested that the day of the big battleship is over, but I am doubtful of this, as I understand that ships can be made proof against ordinary submarine attack by means of blisters filled

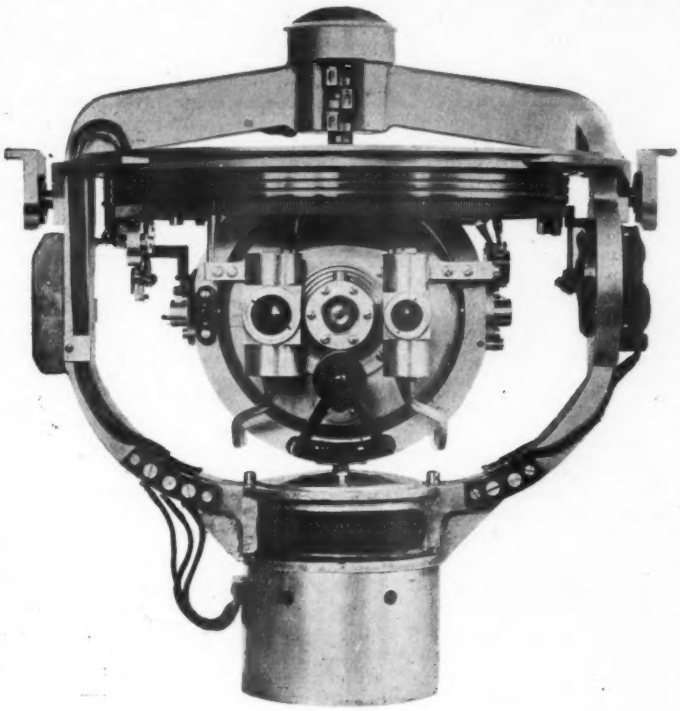

FIG. 5.

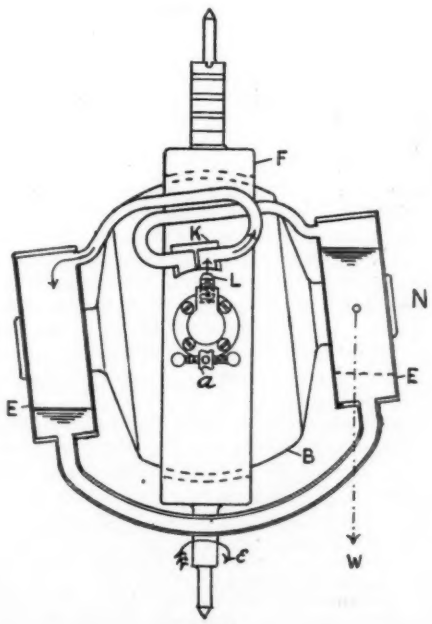

FIG. 6.

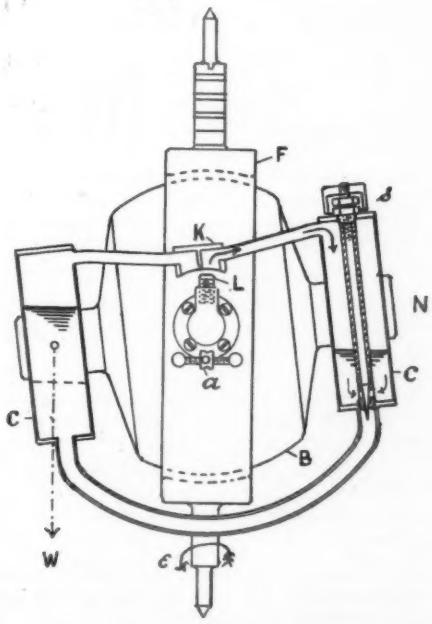

FIG. 7.

with oil, as in our Navy, or by coal-dust, as used by the Germans.

Working the guns with the ships at full speed, as I have just stated, will be an additional protection, while submarine craft will be more dangerous operating against fixed objects, such as harbour defences, etc., in which case they could be detected from the shore by submarine listening devices, such as my liquid microphone.

In closing this discourse, I should like to say that a good deal of credit is due to Anschutz for the courage he displayed in being the first to attempt a gyro-compass, knowing as he did the extremely feeble force that is likely to result from the earth's rotation, and in the fact that the instrument must be carried on a rolling, pitching, plunging vessel. With us who follow it is a question over again of Columbus and the egg. For myself, if I had known at the commencement of my acquaintance with the gyro-compass—some five years ago—all the difficulties that had to be encountered, I think I should have abandoned the pursuit.

Notes.

At the meeting of the Royal Society on June 3 the Bakerian lecture will be delivered by Sir Ernest Rutherford on "The Nuclear Constitution of the Atom."

Sir James Dewar has been elected a corresponding member of the French Academy of Sciences in the section of general physics in succession to the late Prof. P. Blaserna.

The Institute of Research in Animal Nutrition at Aberdeen has received a gift of 10,000*l.* from Mr. J. Q. Rowett. The amount required from public sources for the establishment of the institution is 25,000*l.*

Mr. A. A. Campbell Swinton, during his presidential address to the Wireless Society of London on February 28, reviewed, with the aid of experiments, advances in wireless telegraphy since 1914, and received, in full view of the audience, messages from Gen. Ferrié in Paris and from the Slough station of the Radio Communication Co. These messages were received, not on the usual external aerial, but on a simple loop of wire standing on the lecture-table.

In the course of a speech at a Conference of Provincial and Suburban Wireless Societies, held on February 27 under the presidency of Sir Charles Bright, Capt. F. C. Loring announced that the Post Office is in favour of granting wireless licences of about 10 watts where an amateur can prove that he thoroughly understands the apparatus and is a proficient operator, and that his transmitting station is to be used for genuine experimental work and not merely for communication between other stations in a general way.

We are officially informed that Dr. Carlos Ameghino has been appointed director of the National Museum of Natural History, Buenos Aires, in succession to Dr. Angel Gallardo, who retired in 1916 to become Minister of Education. The new director is the younger brother of the late Dr. Florentino Ameghino, the distinguished palæontologist, who held the same office from 1902 until his death in 1911. During the earlier part of his career Dr. Carlos Ameghino explored many parts of Patagonia and made the great collections of fossil vertebrate remains which were studied and described by his brother. During recent years he has been interested in the evidence for the association of man with extinct mammals in Argentina.

The council of the Linnean Society has issued to the fellows a statement of the present financial position and outlook of the society, recommending them to increase the annual contribution from 3*l.* to 4*l.* The cost of publication is now so high that the Transactions have already been suspended, and the Journal is so much reduced that the issue of many valuable papers has to be postponed for an indefinite time. The due maintenance of the library and the preparation of an up-to-date catalogue are impossible in existing circumstances, and all establishment charges still tend to rise. If the difficulties appeared to be temporary some of the small invested funds of the society might be used, but as there is no prospect of a return to former conditions an increased income is absolutely essential. Nearly all the learned societies are at present faced with similar problems, and the time seems to have arrived when there should be some action in common to consider the possibility of help from public funds.

The following are among the lecture arrangements at the Royal Institution after Easter:—Major G. W. C. Kaye, two lectures on recent advances in X-ray work; Prof. Arthur Keith, four lectures on British ethnology: The Invaders of England; Major C. E. Inglis, two lectures on the evolution of large bridge construction; Mr. Sidney Skinner, two lectures on (1) Ebullition and Evaporation, (2) The Tensile Strength of Liquids; Mr. R. Campbell Thompson, two lectures on (1) The Origins of the Dwellers in Mesopotamia, and (2) The Legends of the Babylonians; Mr. A. P. Graves, two lectures on Welsh and Irish folk-song (with musical illustrations); Prof. W. H. Eccles, two lectures on the thermionic vacuum tube as detector, amplifier, and generator of electrical oscillations; Prof. Frederic Harrison, two lectures on (1) A Philosophical Synthesis as Proposed by Auguste Comte, and (2) The Reaction and the Critics of the Positivist School of Thought; and Prof. J. H. Jeans, two lectures on recent revolutions in physical science, (1) The Theory of Relativity, and (2) The Theory of Quanta (the Tyndall lectures). The Friday evening meetings will be resumed on April 16, when Prof. J. A. McClelland will deliver a discourse on ions and nuclei. Succeeding discourses will probably be given by Prof. H. Maxwell Lefroy, Prof. F. O. Bower, the Right Hon. Lord Rayleigh, Prof. Karl Pearson, Prof. J. A. Fleming, Prof. W. L. Bragg, and other gentlemen.

One of the Industrial Research Associations formed in connection with the Department of Scientific and Industrial Research is the British Empire Sugar Research Association. If the association plans its

work on a sufficiently large scale, and raises 5000l. a year from the trade for five years, grants of the same amount and for the same period will be made from State funds. The offices of the association are in Evelyn House, 62 Oxford Street, W.1. The objects of the association are to establish, in co-operation with the Department of Scientific and Industrial Research, an Empire scheme for the scientific investigation, either by its own officers or by universities, technical schools, and other institutions, of the problems arising in the sugar industry, and also to encourage and improve the technical education of persons who are or may be engaged in the industry. A survey is being made of the field of research which is likely to be beneficial to the industry, and it is proposed to establish a bureau of information to which any member of the association can apply for assistance. In the first instance, the whole of the research undertaken will be carried out in existing institutions, and it will be necessary to enter into agreements with the bodies controlling these institutions for the use of laboratories and the services of skilled scientific investigators. With regard to the actual production of sugar, experiments on the cultivation of the sugar-cane and of the sugar-beet will be undertaken in suitable parts of the Empire. In this connection it is hoped that very close relations will be established with Colonial Agricultural Departments. The organisation and general supervision of the research work will eventually be entrusted to a director of research, and it is hoped to establish a Central Sugar Research Institute if and when it becomes necessary.

IN Algeria most gun-owners are able to trim roughly the flints they require for the long-barrelled muzzle-loading guns and pistols which still form the principal armament of the nation. Mr. M. W. Hilton-Simpson, while engaged in collecting specimens for the Pitt-Rivers Museum, Oxford, came across a specialist who trimmed flints for sale. This worker's methods are fully described in the March issue of *Man*. He employed a rough stone for striking the flakes from the cone, and for trimming the flakes thus struck off he used a small tool resembling in outline the universal general-utility implement of the country, a combination of a hoe and pick. This man's features indicate an infusion of negro blood, but flint-chipping does not seem to be a special negro trade, the man being a resident of one of the oases where there is a negro strain in the population.

OF the eighteen species of ground-squirrels found in the State of California, four, inhabiting cultivated areas, have become pests. The life-histories of these four and of the harmless species have been very carefully described by Messrs. Joseph Grinnell and Joseph Dixon in vol. vii. of the Monthly Bulletin of the State Commission of Horticulture. In one district infested by the Oregon ground-squirrel the authors estimated that there were 112 adults to the acre or 70,000 to the square mile, and that these would consume in one day more than two tons of green forage, which would be sufficient to feed ninety head of cattle during the same time.

BIRD-LOVERS will read with no small pleasure Mr. J. H. Gurney's ornithological notes from Norfolk for 1919 in *British Birds* for March. Perhaps the most interesting of these notes are those referring to the bittern, which seems to be returning to the Broads in increasing numbers to breed. It is satisfactory to learn that, so far as can be ascertained, this year no nests were raided, though in one nest the brood, unfortunately, died. The little owl, he tells us, which up to 1914 was confined to a few districts in the west of the county, is quickly spreading throughout the whole of Norfolk. The prevailing prejudice against this bird he considers scarcely to be justified, since "the test of dissection is rather in its favour than otherwise." During the war vast quantities of a tar-like substance were spread over much of the North Sea for military reasons. One would have imagined that the need for this had now ceased, but in these notes are records of numerous divers and guillemots picked up in an exhausted condition owing to this compound clogging the plumage.

IN the fourth part of his study of the Malacostracous Crustacea obtained by the *Ingolf* and other Danish expeditions from deep water in the seas round Iceland and South Greenland ("The Danish *Ingolf* Expedition," vol. iii., part 6, Copenhagen, 1920), Dr. H. J. Hansen describes the Cumacea and Phyllocarida. Of the former group no fewer than sixty-six species are enumerated, of which twenty-four are new—a surprisingly large proportion of novelties in view of the attention that has been given by G. O. Sars and others to the Cumacea of northern waters. Together with Dr. Hansen's previous memoirs on the Isopoda and Tanaidacea, this report serves to bring into prominence both the extraordinary richness of the micro-fauna of the sea-bottom and the imperfection of our knowledge of it even in the better-known regions of the ocean. From the point of view of systematic zoology, if not also from that of marine bionomics, a one-sided impression is apt to result from confining attention mainly to the more easily studied species of the plankton. In dealing with the Phyllocarida Dr. Hansen is able to throw new light on the structure of the limbs and mouth-parts of the long-known and much-studied Nebalia.

IN the March issue of *Medical Science: Abstracts and Reviews* (vol. i., No. 6), one of the reviews is devoted to the subject of typhus fever. Owing to the war this disease has been very prevalent in Europe during the last four years; for example, in Poland 124,620 cases were recorded between January 1 and July 27, 1919. Lice are the agents by which the disease is transmitted, but the causative micro-organism is still unknown. The blood-serum gives agglutination with a Proteus bacillus, the Weil-Felix reaction, which is of considerable value for the diagnosis of the disease.

AN interesting lecture on the history of electro-therapy by Dr. W. J. Turrell is published in the *Archives of Radiology and Electrotherapy* for February (No. 235). In England electrical treatment appears to have been first practised by the clerical profession.

In 1756 a book on the subject was published at Worcester by Richard Lovett, a lay clerk at the cathedral, in which he records the treatment of a number of diseases with electricity. In 1780 John Wesley, the great divine, anonymously published a book entitled "The Desideratum; or, Electricity made Plain and Useful." In this he appeals to the medical profession for a trial of the curative effects of electricity, and records many alleged cures.

WE have received the first number of a new British journal devoted to pathology, entitled the *British Journal of Experimental Pathology*. It is published bi-monthly under the editorship of a board of editors by Messrs. H. K. Lewis and Co., the annual subscription, post free, being 2*l*. The journal has been founded for the publication of original communications describing the technique and results of experimental researches into the causation, diagnosis, and cure of disease in man. Among the contributors to this first number are Prof. Bayliss ("Is Hæmolysed Blood Toxic?"), Dr. Cramer ("On Sympathetic Fever and Hyperpyrexial Heat-stroke"), Prof. McIntosh and Mr. Smart ("Determination of the Reaction of Culture Media"), and Mr. Fildes ("Serological Classification of Meningococci"). The journal is well produced, and will, we believe, fill a lacuna in the means of publication of research work at the disposal of British pathologists.

MR. W. L. GEORGE, who gave evidence before the National Birth-rate Commission, has contributed to the *Fortnightly Review* for March a summary of the arguments he presented to that body, which does not appear yet to have arrived at a conclusion upon them. The line he takes is that a high birth-rate corresponds with a low degree of education, a low level of comfort, and poor foreign trade. He views, therefore, with calmness, and, indeed, with satisfaction, the recent decline in the birth-rate, and would take active steps in that direction by promoting the understanding of confraceptives and other preventive measures. Whether this could be done without leading to grave evils may be doubted. At any rate, Mr. George is justified in opposing proposals tending in the other direction, such as those for the endowment of motherhood, which would have the effect of encouraging imprudent marriages or illicit connections, and, as they involve an expenditure that he sees is financially impossible, must fall to the ground. He would have us base our quest for national prosperity on good births rather than on more births, on quality rather than on quantity. Like all difficulties that arise out of the passions and the instincts of mankind, the problem is soluble only by an appeal to reason and by a gradual education of the will in men and women. It should be noted that large families have given to the community many valuable members.

A SUPPORTING expedition for Roald Amundsen's trans-polar voyage has been organised by the Norwegian State. Some details from Scandinavian sources are published in *La Géographie* (vol. xxxiii., No. 1). The expedition which reached Greenland last summer is in charge of Lieut. G. Hansen, a Danish naval officer who accompanied Amundsen in the voyage of the *Gjoa* in 1903–5. Lieut. Hansen is now wintering at Etah, in about 78° 15′ N. This month he hopes to leave with a dozen sledges for Cape Colombia, the most northerly point of Grant Land, in 83° N. Stores and provisions for a year will be taken. Amundsen, who proposes to leave his ship, the *Maud*, at the most northerly attainment of its drift, is expected to make for Cape Colombia, and may arrive there in March, 1921.

AT a meeting of the Royal Geographical Society on March 8, a paper was read by Miss E. M. Ward on "The Evolution of the Hastings Coast-line." We can scarcely agree that the Wealden dome stretches from Beachy Head to the North Foreland, as it does not extend beyond the Warren at Folkestone, where the chalk of the North Downs comes down to the sea, or that the North Foreland is in the Channel, as we might be led to believe. It may be pointed out that the eastward-flowing drift of flint beach is general on the South Coast, and that this has resulted in most of the southern-flowing rivers being turned to the east, whilst forming a spit of beach on the seaward side of the stream, this being the result of the conflict between the eastward-flowing tide and the southward-flowing stream. As the streams lost their velocity and carrying power they deposited their silt, and finally the conflict between sea and mud ended in the victory of the former, when the sea made its bold attack on the land, which is still going on, and against which engineers are fighting. The existence and continued growth of Dungeness have never yet been satisfactorily accounted for, but there is some reason to believe that the destruction of the Hastings headland let loose vast quantities of beach which had accumulated on its western side, and that this gave rise to the various low terraces still to be observed on the west side of the Ness. Miss Ward finds it difficult to believe that at Hastings there was a promontory in Neolithic times even so much as seven miles in length, but it is fairly generally believed that the passage between England and France was comparatively narrow in those times, and Prof. Boyd Dawkins even suggested that Neolithic man came across on dry land.

IN the Proceedings of the American Academy of Arts and Sciences (vol. lv., December, 1919), Messrs. George F. McEwen and Ellis L. Michael deal with the functional relation of one variable to each of a number of correlated variables when the representation by linear regression is unsatisfactory. The basal idea is to assume that the dependent variable may be represented by a sum of functions of the independent variables, and to determine these functions by dissection of the material into a series of groups. If, for instance, a variable w is to be expressed in terms of x, y, and z, a series of groups of (w, x), (w, y), and (w, z) are formed; a first approximation to the relation between w and x is obtained by taking the averages of the (w, x) groups; corrections are then derived from the averages of the (w, y) and (w, z) groups; from the second approximations third approximations are derived, convergence being ob-

tained to the values of w corresponding to variations of x alone. Similarly the other functional relations are obtained. The idea of defining a function by means of a series of corresponding values has been utilised by various mathematicians; the most obvious criticism of its statistical applicability is that an immense amount of arithmetic would be required to determine more than a very small number of corresponding values. The method, however, deserves further consideration.

THE *Meteorological Magazine*, an official publication of the Meteorological Office, was first issued under its new title about the middle of February. The journal incorporates *Symons's Meteorological Magazine* and the *Meteorological Office Circular*. For convenience in reference, the serial numbers of *Symons's Meteorological Magazine* are being carried on. The change has come about through the absorption of the British Rainfall Organization in the Meteorological Office. The cover of the new publication gives the portraits of four pioneers of meteorology, all of whom were associated with the Meteorological Office. Of these Admiral FitzRoy had charge of the Office at its initiation, when it was a branch of the Board of Trade, and Mr. Symons was an assistant sixty years ago, but left after a short period and devoted himself to the collection of rainfall returns, from which evolved later the British Rainfall Organization. Gens. Sabine and Strachey were successively chairmen of the Meteorological Office when controlled by the Royal Society. Little change has been introduced into the style and character of the publication, and it is evidently not intended to make any radical alteration. In addition to the interesting article on "Weather in the British Isles" for the preceding month, which has hitherto regularly appeared in *Symons's Meteorological Magazine*, an article is now given on "Weather Abroad" which will doubtless be valued by readers of the journal.

ON March 10 Lord Moulton delivered a lecture at University College on "The Training and Functions of the Chemical Engineer." The lecture was presided over by H.R.H. Prince Arthur of Connaught. Lord Moulton referred to the great importance of securing an adequate and suitable training for those who had to perform chemical operations on a large scale. In a research chemical laboratory work is carried out on small quantities of pure substances with every convenience at hand and regardless of cost and economy. In chemical industry, on the contrary, it is necessary to carry out operations on vast quantities of impure substances with no conveniences and with the greatest possible regard to the matters of cost and economy. The question of change of scale was all-important, since it was extremely difficult to secure on a large scale that uniformity of conditions easily obtained in a research laboratory and fundamental for the success of the operation. Lord Moulton laid great emphasis on the subject of costing and costs, since, as he pointed out, the success of an industrial operation in the real world of chemical industry, as compared with the success of a chemical operation in the ideal world of the research laboratory, depended entirely on its cost. It was a noble and dignified business to make things cheaply so that they could be utilised by large numbers of people. In conclusion, Lord Moulton referred to the fact that the Ramsay Memorial Committee had given 25,000*l.* for the building of a laboratory of chemical engineering at University College. He earnestly hoped that the further sum of 50,000*l.* which was required would be forthcoming. A vote of thanks to Lord Moulton for his interesting lecture was proposed by Prof. F. G. Donnan, who referred to the great work Lord Moulton had done during the war as Director-General of the Explosives Supply.

Mr. James Thin, 54 South Bridge, Edinburgh, has just issued a useful and comprehensive catalogue of new and second-hand books on technical and scientific subjects. The prices named in the second-hand section are very reasonable. A laudable feature of the catalogue is the giving of the dates of publication of the volumes.

THE *Oxford University Press* will shortly publish an English rendering, by H. L. Brose, of "Space and Time in Contemporary Physics: An Introduction to the Theory of Relativity and Gravitation," by M. Schlick, with an introduction by Prof. F. A. Lindemann. The work is intended for the general reader. It deals with the problem of the structure of cosmological space, discusses the relation of psychological to physical space, and analyses the significance of measurements in physics.

THE *Reader's Index*—a bi-monthly magazine issued by the Croydon Public Libraries—for March and April contains much useful guidance for readers, including a reading list of books and periodical articles on the Einstein theory. We notice references to articles in NATURE of June 11, 1914; December 28, 1916; March 7 and 14, 1918; November 13, 1919; and December 4, 11, and 18, 1919.

A NEW series of books dealing with the textile industries has been arranged for by *Sir Isaac Pitman and Sons, Ltd.* The editor will be Prof. R. Beaumont, and one of the first volumes in the series to be published will be that by the editor on "Union Textile Fabrication," which will contain three main divisions dealing respectively with bi-fibred manufactures, compound-yarn fabrics, and woven unions. Another volume in the series will treat of "Flax Culture and Preparation." It will be the work of Prof. F. Bradbury.

MR. D. N. WADIA writes to say that the two illustrations from his "Geology of India" reproduced in NATURE of January 15 were not his own photographs, but from the collection of negatives at the offices of the Geological Survey at Calcutta. Acknowledgment of this was, unfortunately, omitted from the book, and our reviewer assumed, therefore, that the photographs were the author's.

Our Astronomical Column.

THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 20, 1922.—Mr. A. R. Hinks read a paper at the meeting of the Royal Astronomical Society on March 12 on the conditions along the track of totality in this eclipse. The nearest available station is in the Maldive Archipelago, where the sun's altitude is 34½° and duration 4m. 11s. It is recommended that an uninhabited islet be selected, as there is less risk of illness on one of these, the others having a bad reputation for Europeans. Also it should be an islet in the centre of a lagoon, as the outer ones experience vibration from the surf, which would spoil fine definition. The weather is likely to be clear but windy.

Christmas Island, south of Java, is near the noon point; the sun's altitude is 78½° and the duration 3⅓m. at the south point of the island. There are a flourishing phosphate industry on the island, a monthly steamer from Singapore, and good jetties and cranes at Flying Fish Cove, whence there is a railway to the south coast. Much of the island is covered with forest (haunted by large land-crabs), so some clearing might be necessary to give enough sky room for adjusting the equatorial mounting which it is intended to use here. The weather conditions in September promise to be very good.

The west coast of Australia offers difficulties, the country being barren, and there being no port in the neighbourhood of the track. The east end of the track in Australia is in Queensland, just south of Brisbane. The sun's altitude here is only 18°, but it is possible to obtain an altitude of about 26° by travelling by rail into the interior.

The programme will include a repetition of the investigation of the Einstein shift; there is a fair field of stars round the eclipsed sun, though they are much less bright than those of the eclipse of May, 1919.

THE BINARY STAR p ERIDANI.—This southern binary star (R.A. 1h. 36m. 45s., S. decl. 56° 36′) was first noted as double by Dunlop in 1826, and observed by Sir John Herschel at the Cape, 1834 to 1836. It was for some time doubtful whether the relative motion was not rectilinear, but curvature is now definitely established. Mr. B. H. Dawson gives a determination of the orbit in the *Astronomical Journal*, No. 762, as follows:—Period 218·9 years, T 1806·14, e 0·721, a 8·025″, ω 301·40°, i ±114·26°, Ω 1·03°. There is still much uncertainty, as only one quadrant has been observed. The large size of a makes the pair an interesting one. Apastron was passed in 1916, and the stars are now 9″ apart. Both are of magnitude 6·2; the proper motion of the middle point between them is +0·0336s., +0·022″, according to Boss.

FAINT NEBULÆ.—Publications of the Yerkes Observatory, vol. iv., part 2, is occupied with an account of a research on faint nebulæ by Mr. Edwin P. Hubble. Mr. Hubble took a series of photographs, with the 24-in. reflector at the Yerkes Observatory, of some rich nebulous regions, including seven well-defined clusters, containing more than five hundred nebulæ. The measures for ascertaining their positions are given, but, owing to the bad figure of the images in the outer parts of the field, the precision is not considered very great. The exposures did not generally exceed two hours, as beyond that point very little seemed to be gained. The average diameter of the nebulæ is about 25″, but in certain regions, notably in Perseus, they are distinctly smaller, about 15″. The question of the distance and status of these small nebulæ is discussed at some length, but the evidence appears to be insufficient to decide whether they are in the remoter parts of the galactic system or altogether outside it.

International Fishery Investigations.

THE first meeting since the autumn of 1913 of the International Council for the Exploration of the Sea took place in the Surveyors' Institution, Westminster, on March 2–6. The Council exists to consider and conduct investigations into the fisheries of the North Atlantic; to examine how far these fisheries are being depleted by fishing; to investigate natural methods, such as by breeding, etc., of keeping up the stock; and in cases of certain future failure of supply to suggest the necessary remedial measures. The Council has been conducting researches for nearly twenty years, but its operations during the war were brought almost to a standstill. For the most part it deals with the sea-fish common to all countries, but a special sub-committee considers the salmon, and a second the eel; shellfish are not investigated. The countries represented were France, Belgium, Holland, Denmark, Sweden, Norway, Finland, and Great Britain, each country having two delegates, with scientific experts from the fishery authorities of each. France was represented for the first time, but Germany and Russia dropped out of representation; the meeting was too hurriedly convened to allow of the U.S. Congress appointing delegates, and there was no representative of Canada, the eastern fisheries of which are mainly coastal. Great Britain was represented by Mr. H. G. Maurice and Prof. D'Arcy Thompson as delegates, Mr. Holt representing Ireland, while most of the scientific staffs of the three countries took part in the deliberations of the committees, including Prof. Stanley Gardiner (temporary Director of Fishery Research) and Comdr. Jones (of the Scottish Office).

March 2 was devoted to general business and the formation of committees, the whole body meeting together under the chairmanship of Prof. Petterssen (Sweden). After a telegram of respectful homage had been dispatched to the King, the chairman referred in sympathetic terms to the troubles of the last years and to the increased importance to Europe of safeguarding its supplies of fish. Commodore Drechsel (Denmark) and others spoke of the closure of the greater part of the North Sea as the most gigantic scientific experiment ever made in respect to the closure of areas, and one from which we might be able to draw the most important deductions in respect to the conservation of our fish supply. Mr. Maurice pointed out the difficulties under which all countries are at the present time labouring, and appealed to all to help in drawing up practical programmes of work such as each country could guarantee to carry out. The meeting then split into two committees for fishery investigations and fishery statistics and for hydrography and plankton (floating life in the sea).

The committees met twice daily during the next three days to draw up their programmes to be submitted on Saturday, March 6, to the whole body of delegates. The main deliberations of the Fish Committee were in respect to the plaice. All were agreed that the fishery statistics of Western Europe up to 1914 proved that there had been a most serious depletion of the stock of plaice on the fishing-grounds of Western Europe, particularly in the southern half of the North Sea. The apparently probable disappearance of this fish, from the point of view both of the industry and of the consumer, was felt to be so calamitous that even the strongest measures were thought to be justifiable. It was proposed that the Council should suggest to the diplomatists to negotiate a size-limit and the permanent closure of certain areas to provide a reserve, from which the young plaice might spread so as to restock the open grounds. It was pointed out that Denmark had already insti-

tuted a size-limit of nearly 10 in., but that Holland did not favour one of more than about 8 in. The representatives of Great Britain considered that the effect of the closure of areas on the industry had not been sufficient studied; that the closed areas must be as small as possible, consistent with the preservation of the plaice stock of the North Sea; and that the study of the effect of the war in having closed great areas would materially assist the Council in arriving at the most practical results.

The British view was finally adopted, and it was decided to undertake a year's intensive plaice investigation with the view of considering the whole question in 1921 and making recommendations. The committee then proceeded to draw up a programme of investigations. A thorough collection of statistics of plaice marketed was deemed essential. Furthermore, an accurate knowledge of the sizes of the fish both as marketed and as caught on commercial trawlers was recommended. The liberation after marking of a series of fish would be necessary to show their wandering during the year. Further experiments in the liberation of marked fish of small size on the Dogger Bank were recommended. The spawning-grounds should be more fully investigated and charted. The liberation of a large series of drift-bottles, both surface and bottom, was deemed essential so as to ascertain the drift of the eggs and young larvæ which float for many weeks in the water. The examination of numbers of eggs so as to ascertain the intensity of spawning in different areas was deemed advisable, as well as an investigation into the food on which the larvæ feed.

As most of the spawning areas of the plaice are off the east coasts of Great Britain, it was generally recognised that this country would have to concentrate in the present year mainly on these plaice investigations, but the hope was expressed that the examination of the life-history and wanderings of the lemon-sole would not be neglected, while the other fish occupying plaice grounds should be carefully recorded. The continued examination of the constitution of the herring shoals and of the other work on the life-history, growth, etc., of the herring was recommended, Great Britain being requested to collect samples and to send them to Norway, the representatives of which (Dr. Hjort, Prof. Gran, and Dr. Lea) undertook to examine them.

The Danish representatives described their plans for a second great expedition in the North Atlantic to search, among other objects, for the spawning-grounds of the fresh-water eel, which their previous work showed to be somewhere in the latitude of Madeira and at depths of at least 1000 or 1500 fathoms. They also gave an account of the commercial results obtained by the importation of the young eels (elvers) and their liberation in Danish rivers and lakes. Dr. Johansen (Denmark) and Dr. Rosen (Sweden) described the work of their respective countries on the movements of salmon and sea-trout, the ages of these fishes for spawning, the liberation of fry, etc., showing results of considerable economic importance—results capable of immediate application in many British rivers could the difficulties in respect to pollution be overcome.

The Hydrographical and Plankton Committee divided into sub-committees for its two subjects. The former is mainly concerned with the currents on the fishing-grounds in respect both to the movements of such fish as herring, mackerel, and pilchards, and to the drifting of fish-eggs and young. It was generally considered that the hope of foretelling the movements of the fish and the success or otherwise of the spawning year by year depended on a more extensive study of the movements of Gulf Stream waters from Barents Sea to Iceland and down the European coasts to Mogador, with more intensive investigations in the North Sea. The nature of the spawning was deemed peculiarly important, as on this depends to a large degree the success of the fishing some years afterwards when the spawn has grown into fish of marketable size. Extensive temperature records and water samples from a series of transoceanic liners month by month were recommended, and the hope was expressed that the United States would co-operate by collecting samples on liners cutting the Gulf Stream nearer where it leaves the Straits of Florida.

A full programme of hydrographic work was recommended in the southern half of the North Sea in view of the plaice investigations. Here the sea is so shallow that the water is thoroughly churned up from surface to bottom, and, in consequence, surface samples only, mostly from passenger ships, were proposed. The drift-bottle programme was approved and somewhat extended in the hope of understanding better the isobaric, temperature, and salinity charts of the region in respect to the movements of fish, with the view of making them usable by fishermen.

The plankton sub-committee, under Prof. Gran, drew up a very small programme on account of present difficulties, but it decided to recommend researches on the physico-chemical conditions of sea-water in respect to the life in the sea. It regarded this basal research as impossible either to initiate or carry out under the Council, and so decided to record its opinion as to the necessity of such researches on living animals in respect to the water in which they live. It was pointed out that the acid or alkaline nature of the water affects the rate of growth of young fish, and that further knowledge here in respect to trout, salmon, and plaice might become at once of economic importance. Animals, too, show growth in the most carefully filtered sea-water—a matter of the greatest importance, the meaning and utility of which could not be foretold. It is well known that the blood of human beings can be replaced by sea-water, but not so effectively by artificial sea-water, which is made from distilled water by dissolving in it the various salts. The possible meaning of this was discovered by Dr. Allen (Plymouth) working on minute marine animals, and points to those mysterious substances "vitamines," of which so much has been heard in the last six years and so little is known. The searcher for economic results in fisheries must have the basal theory and knowledge in respect to his living fish duly developed as the foundation on which he has to build. Incidentally, an increase in knowledge of this soluble food, etc., should be rapidly applicable to oyster- and mussel-farming, and the sub-committee could only hope that the requisite genius to give further ideas would soon be found.

The development of lakes and rivers for the production of food was of special interest to Mr. Holt (Ireland), the Swedish and Finnish representatives, and Dr. Redeke (Holland), the last giving an account of the very great development of the fresh-waters of his country. So far as fish were concerned—salmon is treated separately—the subject is of little importance to Great Britain, but the possibility of the development of a button industry by the cultivation of mussels was thought worthy of investigation.

France was represented by M. Kersoncuf (Director of Marine Fisheries), accompanied by M. Tissier, Prof. Behal, Prof. Joubin, and Dr. le Danois. A meeting with the English and Irish representatives resulted in the formation of a special committee to consider and report as to fisheries off the mouth of

the English Channel and in the Bay of Biscay and to the west and south. The chief fish of this region are the migratory mackerel and pilchard and the hake, which apparently is a great wanderer. It is hoped also to investigate the possibilities in respect to tunny, of which there should be an almost unlimited supply in the Atlantic. France undertook the preparation of a fishing chart of certain grounds, Ireland particular cruises to meet the French vessel, and England to continue and extend her investigations into the waters of the Channel. England was also asked to undertake, as soon as possible, regular cruises to the south-west to investigate the approach of the Gulf Stream waters in respect to mackerel, pilchards, and tunny.

At the full meeting on Saturday, March 6, the programmes of the committees were adopted, and Mr. H. G. Maurice was unanimously elected president for the ensuing year, the next meeting to be held in Copenhagen in 1921. The present writer believes that the fishery industry appreciates the vital importance of these very technical investigations, in the results of which the interests of the fisherman and the researcher are identical; he appeals to the industry to co-operate in every way in its power, and in particular to return drift-bottles and marked fish.

Exhibition of Diseases of the Para Rubber-tree.

AN important exhibition illustrating the fungal diseases to which the Para rubber-tree (*Hevea brasiliensis*) is subject in Ceylon and Malaya was opened on March 10 in the Botany Department of the Imperial College of Science and Technology by the Marquess of Crewe in the presence of leading representatives of the rubber trade. The exhibition, which has been organised by Prof. J. B. Farmer, Director of the Biological Laboratories of the college, includes a large number of trunks of rubber-trees, specially shipped from the East, showing the diseases as they occur in the plantation, and forms a striking commentary on the optimism which obtained in the first years of the industry as to the probable relative immunity of Hevea from disease.

The warnings issued by botanists at the time that the Para rubber-tree would no more escape epidemic fungal disease than any other crop plant has, unfortunately, been justified by events. At the present time there are several diseases which, if not checked as the result of sound scientific knowledge, intelligently applied, may seriously affect the future of the plantation industry. The former optimism finds a present-day counterpart in the equally dangerous view held in certain quarters that "sanitation" is all that is necessary as a safeguard against disease, and that, in consequence, expenditure on mycological research is waste of money. The fact that the causative organism (if organism it be) of the most dangerous disease in the plantations at the present time ("brown bast") is as yet unknown is sufficient reply to so short-sighted a view. The exhibition comprises three main sections: (1) A series of rubber trunks affected by the chief diseases met with in the East, illustrated by admirable coloured wall-pictures of the diseases *in situ*; (2) cultures and microscopic preparations of living fungi isolated at the college from the trunks exhibited; and (3) a section devoted to the important bearing of a knowledge of the anatomy of the bark of the tree upon questions of latex yield. This section also includes trunks illustrating different systems of tapping. All the exhibits are accompanied by explanatory labels.

The principal diseases represented are as follows:

(1) *Brown Bast.*—This is by far the most important disease at the present time, and is rapidly increasing, certain estates in Java having as many as 60 per cent. of the trees attacked. It is an affection of the bark in the tapping area, and is of acute importance, since it quickly results in the complete cessation of latex flow. Later, the bark becomes discoloured and burrs appear over the affected area. The disease is met with on young and old and on vigorous and backward trees, and occurs in every type of soil. At present preventive measures are confined to disinfection and excision of the affected tissues, but successful treatment is hindered by ignorance of the real nature of the disease. Hitherto physiological disturbance produced by tapping has been held to be the cause, but recent work in Sumatra suggests a bacterial origin. Further research alone can settle this fundamental question.

(2) *Fomes lignosus.*—Next to brown bast this is the most serious disease of Hevea. It is a fungus of the familiar Polyporus type, attacking the cortex of the roots. In cases where it was neglected in the early stages it has since wiped out large blocks of rubber, and from the nature of the disease the replanting of such areas has been impracticable. The mycelium spreads to the Hevea roots from old jungle stumps, or from soil in which old jungle roots have been lying. From the infected Hevea roots it passes to all healthy roots in the vicinity, finally destroying the trees. Treatment consists in exposing the root-system and painting the diseased roots with Bordeaux mixture or other fungicide. The soil is also heavily limed to destroy the mycelium invariably present in it, and the whole infected area isolated by a trench.

(3) *Fomes pseudoferreus* (*Poria*).—This fungus penetrates deeply into the wood of the Hevea roots, often leaving the cortex as a living cylinder until the wood is destroyed by a "wet rot." The tree thus shows little external signs of attack until the disease has reached the final stage. In consequence, measures of dealing with Poria are limited to preventing its spread. The treatment adopted is essentially the same as for *Fomes lignosus*.

(4) *Dry Rot* (*Ustulina zonata*).—This fungus is a wound parasite, and gains entrance *via* lesions on roots, stems, and branches, killing the wood, which becomes soft and tindery. Owing to former neglect of wounds, the disease is greatly increasing in older plantations. The best preventive treatment is a periodical dressing of all wounds with tar. When confined to the branches the disease may be removed by pruning, but if on the base of the trunk or on the roots, the tree is usually found to be infected with Fomes in addition, and treatment is impracticable.

(5) *Patch Canker* (*Phytophthora Faberi*).—This disease is increasing in all the rubber-growing countries of the East. The bark just below the surface becomes claret-coloured, and eventually dies off in patches. The disease can be controlled by early removal of the bark and coating the exposed surface with tar, but the chief difficulty is that the affected bark is freely entered by boring beetles which penetrate deeply into the wood, carrying with them spores of dry rot (Ustulina). In consequence, nearly every case of neglected patch canker is also infected with dry rot.

(6) *Stripe Canker* (*Phytophthora sp.*).—This canker was a formidable menace during 1915–17, more than 70 per cent. of the trees in tapping on some estates being attacked. The disease first appears as narrow vertical stripes just above the newly tapped bark, and if tapping is continued during the wet season the whole of the tapping surface rots away. Fortunately, it is now almost completely preventable by daily disinfection of the tapping cut.

(7) *Pink Disease* (*Corticium salmonicolor*) has

caused much damage in the East. It rarely attacks very young trees, and develops most rapidly during periods of heavy rain. Manifestations of the disease are extremely variable, but a common form, viz. a pink encrustation on the branches or main stem, gives the disease its popular name. Once the bark is penetrated the fungus spreads rapidly, destroying the cortex, and frequently enters the wood, interrupting the water-supply to the branches, which turn brown and die. So far the best treatment has been the removal of infected branches, or by treating the diseased parts with tar. Except in special cases, spraying is not practicable.

In the section devoted to fungal cultures and preparations, the following fungi, among others, have been isolated and grown from the trunks exhibited: *Cyphella heveae*, a cause of "thread blight" disease; *Botryodiplodia theobromae*, a cause of "die-back"; *Fomes lignosus*; Hyphomycetes associated with Botryodiplodia. In addition to living cultures of these fungi on potato and banana agars, interesting experiments are in progress with the view of ascertaining the effect of the vitality of the host upon the potency of the parasite. The fungi have therefore been sown (on wounds) on apple-twigs respectively healthy, of low vitality, and dead, and the cultures kept in a saturated atmosphere and at 25° C.

The third section well illustrates by means of diagrams the important relationship between the anatomy of the rubber stem and the yield of latex. In high-yielding trees the bark shows a large number of rings of latex tubes and a high relative proportion of soft bast as compared with hard bast, which latter contains abundant groups of stone-cells interrupting the rings of latex tubes. In good yielders the stone-cells are more or less confined to the external part of the cortex; in low yielders they are distributed in depth. The well-known superior yield of tapping cuts made from left to right over cuts made from right to left is due to the oblique course of the latex tubes in the bark. This important fact is explained in a large diagram. Mr. H. Ashplant exhibits elaborate statistics showing individual daily tapping yields obtained by different coolies on one estate over a period of three years. The figures show that highly skilled tappers working a group of trees previously tapped by average or poor tappers may collect from 50 to 200 per cent. more latex than the unskilled men. This fact results from the variable depth of the cut made by the inferior tappers, who do not reach the more internal rings of latex tubes. A further interesting point is the favourable influence of a good tapper's work on the yield obtained by an average tapper succeeding him in the same block.

It is much to be hoped that efforts will be made to maintain and develop the present exhibition as a permanent museum of the economic mycology of *Hevea brasiliensis*. Such a museum, with its natural complement of an information bureau, would be of the greatest practical value to the home representatives of planting interests and to the industry generally. The exhibition demonstrates in the clearest fashion the supreme importance of scientific research in this vital aspect of rubber-planting. New diseases are bound to occur in the future, and it may be disastrous to wait until the plantations are seriously affected before taking steps to secure expert advice. Adequate scientific staffs should be continuously engaged in studying the complete biology of Hevea, so that in the advent of a new disease experienced specialists could be detailed at once to cope with it. It is, however, essential that such staffs should be composed of men of first-rate ability and training, for where so much is at stake anything short of the best is worse than useless. Moreover, the best men afford the greatest chance of effecting the desideratum in combating all disease, viz. the stitch in time. The industry must be prepared to pay for such men, but there can be no question that money generously and wisely spent on these lines would be repaid times over.

The Position of the Meteorological Office.

DR. C. G. KNOTT, president of the Scottish Meteorological Society, has sent us a copy of the following resolution passed by the council of the society with reference to the present position of the Meteorological Office:—

"The council of the Scottish Meteorological Society have had under consideration the information published regarding the future status of the Meteorological Office and its relation to various Departments of State. They recognise that an incorporation in one of the great Departments of State is desirable, and realise that meteorology has much to gain by an intimate connection with the Air Ministry. At the same time they have in view that the State Meteorological Office has many other departments and interests to serve, not the least of which are those of pure research. They feel that any system by which the policy of the Office was directed by the interests of only one Department might in certain circumstances hamper its proper development. The science of meteorology made notable advances in many directions under the liberty enjoyed by the Director of the Office with the administrative committee as constituted in 1905. The council urge that, whatever constitution it may be convenient to give to the Office, the public, departmental, and scientific interests of the science should be safeguarded by expressly and personally charging the Director with the care of meteorology in all its branches. Under such an instruction the Director could be relied upon to organise the service upon a scientific plan and to build up the administrative elements in accordance with the demands made upon him. The council also feel that any step which will modify the functions and responsibilities of the Meteorological Committee should be taken only after searching inquiry by a Departmental Committee into the necessity for any modification, and the probable effect of such modification on the work of the Meteorological Committee."

Earthworks and Retaining Walls.

IT is admitted that our knowledge of earthwork problems is far from complete, and the information given in two papers read at the Institution of Civil Engineers on February 10 forms a welcome addition. Mr. Ponsonby Moore Crosthwaite has made experiments on the horizontal pressure of sand, and finds that the angle of internal friction is much less than the angle of repose. The experiments show that the pressures on a wall, as calculated from the Rankine and Colomb theories, are much too high, especially for surcharged walls. Further experiments show that the wedge theories which take account of the friction between the wall and its backing give correct results if the wall is not surcharged, but break down for surcharged walls. By modifying the wedge theory so as to neglect the friction on the back of the wall, and introducing the angle of internal friction instead of the angle of repose, marked agreement was found with the experiments for surcharged walls.

Experiments were made with the object of testing whether the friction between the wall and the backing was of importance, and these showed that this friction did not affect the horizontal thrust.

The second paper, by Mr. Angus Robertson Fulton, gives an account of experiments made on the overturning moments on retaining walls. The method of direct measurement of the moment was employed; the filling was of three kinds: (1) clean river sand, (2) gravel, and (3) garden soil. The total height without surcharge was limited to 7 ft., and with surcharge it reached 9 ft. The experiments without surcharge show that results calculated from the Rankine theory are greatly in excess of the observed values, while those obtained from the wedge theory approximate fairly closely to experiment. For surcharged vertical walls with unlimited slope the wedge and Rankine formulæ give values too great by 20 and 50 per cent. respectively. In the whole series of experiments the greatest discrepancy occurred with the 7-ft. levels (no surcharge) when gravel-filling was used, and was worst with the wall inclined outward. Low experimental values were also obtained in the sand tests at the lower level under surcharge. Mr. Fulton concludes that the wedge theory gives good results with material uncompacted for walls in which the inclination of the inner face is not greater than usually obtains in practice.

Fellowship of the New Zealand Institute.

AT the annual meeting in 1919 of the Board of Governors of the New Zealand Institute it was decided to establish a fellowship of the institute, since—apart from Hutton and Hector memorial medals, which can be gained only by very few—there are no honours attainable in the Dominion for those engaged in scientific research, the number of whom has greatly increased in recent years, while more branches of science are pursued than formerly. This fellowship, which entitles the recipient to place the letters "F.N.Z.Inst." after his name, is limited to forty fellows, and not more than four are henceforth to be elected in any one year until the number is complete, after which only such vacancies as occur may be filled.

In order to make a commencement, and as there were many who well deserved recognition for their long and valuable services to science, it was resolved that, in the first place, twenty original fellows should be appointed, these to consist of the living past-presidents, together with Hutton and Hector medallists (ten in all), and of ten more members of the institute who were to be elected by the past-presidents and medallists from persons nominated by the various affiliated branches of the institute.

The fellowship is to be given only for research or distinction in science, and it is plain that the distinction even now is far from easy of attainment, and that, as time goes on, its value will greatly increase. The election and appointment of the original fellows took place at the close of 1919, and resulted as follows:—Mr. B. C. Aston, *‡Prof. W. B. Benham, †Mr. Elsdon Best, *†Mr. T. F. Cheeseman, *†Prof. Chas. Chilton, *†‡Dr. L. Cockayne, †Prof. T. H. Easterfield, Prof. C. C. Farr, Mr. G. Hogben, Mr. G. V. Hudson, Prof. H. B. Kirk, †‡Dr. P. Marshall, *Dr. D. Petrie, †Sir Ernest Rutherford, Prof. H. W. Segar, Mr. S. Percy Smith, Mr. R. Speight, Prof. A. P. W. Thomas, *the Hon. G. M. Thomson, and Dr. J. Allan Thomson. * signifies past-president; † Hector medallist; and ‡ Hutton medallist.

The Proposed University of Reading.

LORD HALDANE'S conception of the division of the country into areas in each of which a "civic university" caps the provincial education scheme is coming to be recognised as not only wise and far-seeing, but also essential. In Georgian and Victorian days a university was looked upon as primarily an institution for the completion of the teaching work of public schools. The wider view is taken now of the university as a focus of the intellectual life of the community which it serves and as a centre for research.

When in 1902 it was proposed that the Victoria University should be split up into the Universities of Manchester and Liverpool, many regarded the multiplication of degree-giving bodies with apprehension. It was feared that it would lead to a competition downwards. The reverse of this has happened. Leeds, Sheffield, and Bristol have secured independent universities, and each of them fears, above all things, the imputation that its degrees are less desirable than those of any other.

Reading is now seeking a charter. This project is not new. In 1911 the college received great endowments from Mr. and Mrs. G. W. Palmer, Lady Wantage, and Mr. Alfred Palmer, given for the purpose of enabling it to qualify for a charter. The scheme was interrupted by the war, but has now been taken up again with the utmost vigour. Three or four only of our modern universities have so large a permanent source of income. Its students are now more numerous than were those of two chartered English universities before the war.

In the provision of residential accommodation Reading is unique. Its six hostels lodge upwards of four hundred students. The college has also certain definite claims to be regarded as a national institution. In addition to the faculties of letters and science and the departments of fine arts, music, and domestic subjects, its distinctive line of study is agriculture, horticulture, and dairying. In these subjects it is a most important centre of research. Students go to it, not only from the whole of the United Kingdom, but also from the Continent and the British Dominions overseas.

The desire for independence is most natural. As matters stand at present, its professors and lecturers have no voice in determining the conditions for degrees, in settling the syllabuses of teaching, in carrying out the examinations, or in marking their students' answer-papers.

University and Educational Intelligence.

CAMBRIDGE.—Prof. Horace Lamb, Sir Thomas L. Heath, Prof. W. H. Bragg, and Dr. Henry Head have been elected honorary fellows of Trinity College.

Mr. A. Amos, Downing College, has been appointed University lecturer in agriculture, and Mr. G. U. Yule, St. John's College, re-appointed University lecturer in statistics.

A Smith's prize has been awarded to S. Pollard, fellow of Trinity College, for an essay on "The Stieltjes Integral and its Generalisations."

The following grants have been made from the Gordon-Wigan fund:—50*l.* for plant-breeding experiments, 50*l.* for an experimental gas chamber in the physiological laboratory, 50*l.* to assist in the provision and display of entomological specimens, 30*l.* to help in the study of Pleistocene deposits round Cambridge, and 50*l.* towards a deficit on the working of the botanical department.

The Secretary of the Royal Commission on Oxford and Cambridge Universities gives notice that all members of the University who desire to submit representations on matters falling within the terms of reference of the Commission should forward written memoranda in triplicate to him at 22 Carlisle Place, S.W.1, if possible by the middle of April.

Fresh regulations for the diplomas in agriculture and forestry have been drafted. It is proposed to establish a diploma in horticulture, and, further, to include horticulture in the subjects to be examined upon for the degree of B.A. in agriculture, estate management, and forestry.

THE Senate of the University of Dublin has decided to grant the following honorary degrees:—*D.Litt.*: Dr. William Crooke. *LL.D.*: Lord Bryce and Sir Donald MacAlister. *M.D.*: Sir Archibald E. Garrod, Regius professor of medicine in the University of Oxford. *D.Sc.*: Prof. W. H. Bragg, Quain professor of physics in the University of London, and Prof. R. A. Millikan, professor of physics in the University of Chicago.

A ROYAL COMMISSION has been appointed to inquire into the financial resources and working of the University of Dublin and of Trinity College, Dublin, and to consider the application which has been made by the University for State financial help. The members of the Commission are:—Sir Archibald Geikie, Sir John Ross, Dr. A. E. Shipley, Prof. J. S. E. Townsend, and Prof. J. Joly. Prof. G. Waterhouse is to be the secretary to the Commission.

THE governing body of the Imperial College of Science and Technology has made arrangements for the provision, partly from its own funds and partly from the gifts of donors for this special purpose, of six post-graduate scholarships for advanced work and research to be held in the coming year at American universities. It is hoped that arrangements may be made for interchange by the reception at the Imperial College of a corresponding number of university students from America. Lord Crewe, chairman of the governing body, has received the following letter from Viscount Grey:—"It is most desirable that young men of the rising generation, who will do much of the public work here and in America in the coming years, should get to know each other's universities. It will help both countries to realise how much the British and American peoples have in common, not merely in language, but in thought and in political views and aspirations. I am sure the interchange of students between British and American universities is most valuable both to individual students themselves and generally in promoting friendship based upon true understanding."

A WELL-ATTENDED meeting of teachers of the Incorporated Colleges and Schools of the University of London was held at King's College on Friday, March 12, under the chairmanship of Prof. W. A. Bone, of the Imperial College of Science and Technology, to consider the position of university teachers in relation to the Teachers (Superannuation) Act. The chairman pointed out that, as the Act is framed, university teachers are expressly excluded from its benefits. This exclusion will inevitably set up a barrier between the schools and the universities, and prevent the free transition of teachers from the one to the other, especially as the salaries of university lecturers compare most unfavourably with those in the better secondary schools. Financially, the benefits under the Teachers Act are much greater in almost all respects than under the existing contributory scheme for university teachers, which makes no provision in respect of the years of service of a teacher prior to his joining the scheme, whereas the Act is retrospective and takes account of all years of recognised service. As the scheme was only instituted in 1913 this is a matter of serious concern to the older university teachers, for whom the provision on retirement is totally inadequate. The new scales of salaries and the Teachers Superannuation Act have made the school-teaching profession much more attractive than in the past, and unless the universities are placed in a position to offer salaries and retiring allowances at least comparable with those offered to teachers in secondary schools, they cannot maintain their efficiency and attract the abler graduates to their service. After discussion the following resolution was passed with only five dissentients:—"That this meeting of whole-time teachers in the Incorporated Colleges and Schools of the University of London hereby requests the Government to extend to university teachers and administrative officers all the benefits of the School Teachers (Superannuation) Act, 1918." A committee was appointed to take further action in conjunction with the Association of University Teachers.

Societies and Academies.

LONDON.

Royal Society, March 4.—Sir J. J. Thomson, president, in the chair.—Dr. F. F. **Blackman**: The protoplasmic factor in photo-synthesis. The centre of interest in problems of the photo-reduction of CO_2 in green photo-synthesising cells is shifting from the chlorophyll to the protoplasm. The quantitative control of photo-synthesis in the normal green cell is determined protoplasmically. This is illustrated by the temperature relations, which are not those of a photo-chemical reaction, but of a dark reaction. The photo-synthetic activities of leaves of different varieties (green *v.* golden leaves) and at different stages of development show no relation to the amount of chlorophyll that they contain, as is brought out by the "assimilation numbers" of Willstätter. The relation between chlorophyll development and photo-synthesis development, described in the next communication, furnishes another instance of the dominance of factors other than the pigment. In many lower organisms we find the power of reducing CO_2 to form organic matter by chemical energy in the absence of pigment or light. This chemo-synthesis may be the sole or only an alternative source of the carbon for the living cell. The process involves, of course, no cosmic gain of energy. In these cases the efficiency of energy transference from the oxidation of various substances to the reduction of CO_2 seems to be as great as or greater than in the utilisation of light energy for photo-reduction of CO_2.—G. E. **Briggs**: The beginning of photo-synthesis in the green leaf. In young leaves development of the power of photo-synthesis is found to lag behind development of chlorophyll, so that a green leaf when young may exhibit very slight or zero photo-synthetic power. This means that photo-synthetic activity demands development of some other internal factor than chlorophyll. The potentiality of this other factor rapidly increases with age day by day, even when the leaf is kept in darkness continuously. By keeping a leaf in a very low partial pressure of oxygen, further development of chlorophyll can be completely arrested, even in continuous light. Here also, starting with a leaf of feeble green tint, there is similar day-by-day increase in photo-synthetic power, in spite of there being no further greening. Experiments were carried out by

means of a new apparatus designed by Dr. F. F. Blackman for measuring a small output of oxygen in photo-synthesis. The leaf is illuminated in a closed circuit in an atmosphere of hydrogen and carbon dioxide. In part of the circuit gases are carried over palladium black, so that oxygen produced unites with two volumes of hydrogen. The threefold reduction of volume resulting is measured by a gas burette in the circuit. In this apparatus oxygen pressure is kept so low that no further development of chlorophyll takes place, while photo-synthetic production of oxygen can be measured with great accuracy. If a leaf is cut from a seedling growing in the dark at an early stage of development, and then partially greened by exposure to light in air, its photo-synthetic activity when transferred to the apparatus will be very small or nothing. If exactly the same procedure is repeated a few days later, the photo-synthetic activity may be nearly as great as in the normally developed leaf.—Dr. B. **Moore**, E. **Whitley**, and T. A. **Webster**: Sunlight and the life of the sea. [Studies of the photo-synthesis in marine algæ. (1) Fixation of carbon and nitrogen from inorganic sources in sea-water; (2) increase of alkalinity of sea-water as a result of photo-synthesis and as a measure of that process; and (3) relative photo-synthetic activity of green, brown, and red seaweeds in light of varying intensity.] The vernal outburst of green life which occurs at the spring equinox is occasioned by the rapid change in intensity of daily illumination. A study of the seasonal variations in plankton around Port Erin, Isle of Man, has now been carried on for many years by Prof. W. A. Herdman and his co-workers. In many years the great outburst of diatoms occurs before the temperature of the water has even begun to move from its winter level. It thus becomes clear that it is the longer, brighter day, with increased altitude of the sun, which is the primary factor in the sudden dawn of the life of the sea each spring. This is illustrated by a chart upon which are shown for each month (1) temperature of the sea, (2) number of diatoms, (3) hours of bright sunshine, (4) total radiant energy, and (5) the amounts of nitrogen peroxide present in the air (formerly called "ozone of the air" or "active oxygen"), as taken at Radcliffe Observatory, Oxford, by Schönbein's "Ozone" papers. A sudden rise in radiant energy in March is accompanied by (1) the diatomic outburst and (2) increased nitrite content. It has been shown that the growing diatoms capture this enormous increase of light, and utilise it for building both carbon and nitrogen into their organic substances. The source of the nitrogen is the atmospheric elemental nitrogen dissolved in the sea-water, and not ammonia, nitrites, or nitrates. The source of the carbon is the carbon dioxide of the bicarbonates of calcium and magnesium dissolved in sea-water. As this carbon is removed in photo-synthesis the sea becomes always more alkaline, and the change of reaction can be used as a rough measure of the marine crop. Although the increase of alkalinity is small, yet the volume of sea-water is so immense that, as has been pointed out by Moore, Prideaux, and George Herdman, supposing this to happen to a depth of 100 metres over the surface of the sea, then the crop of moist plankton per square kilometre would amount to about 1,500,000 kilograms. This corresponds roughly to about 10 tons per acre.

Royal Microscopical Society, February 18.—Prof. John Eyre, president, in the chair.—Dr. Agnes **Arber**: (1) Studies on the binucleate phase in the plant-cell. Rudolf **Beer** and Dr. Agnes **Arber**: (2) Multinucleate cells: an historical study (1879–1919). These two papers were read as one. It was pointed out that in 1844 Nägeli first stated that the plant-cell is essentially uninucleate. Those botanists who have from time to time directed attention to exceptions to Nägeli's rule, usually attributed little importance to them, but recent work has made it clear that a binucleate or multinucleate condition is a very constant character of young and active tissues. The authors' observations on the subject were then discussed, the case of the nuclei of the young inflorescence axis of *Eremurus himalaicus* being described in detail. It was shown that the binucleate condition arises by mitosis. The division is normal up to the formation of the daughter-nuclei and the initiation of the cell-plate. At this point the mechanism apparently breaks down, the cell-plate is resorbed, and the spindle-fibres and associated cytoplasm—the "phragmoplast" of Errera—become transformed into a hollow sphere which encloses the two daughter-nuclei, and eventually, by gradual expansion, merges with the cytoplasm lining the cell-wall. For this hollow shell, derived from the phragmoplast, the authors have proposed the term "phragmosphere" (Proc. Roy. Soc., B, vol. xci., 1919, p. 10). The question as to how the binucleate condition of these young cells passes into the uninucleate condition characteristic of mature tissues, was then considered. It was shown that, although bilobed nuclei often occur, which at first sight suggest that the two nuclei have fused together, more critical examination indicates that these nuclei are *single nuclei*, the lobing of which is an indication either of senility (axis of Asparagus) or, in some cases, of an effort by young and active cells to increase their nuclear surface (stelar parenchyma of roots of Stratiotes, leaf epidermis of Hemerocallis). The authors think it more probable that the uninucleate condition is restored by degeneration and resorption of one nucleus, than by the fusion of the two nuclei. The paper closed with a brief reference to the significance of the multinucleate phase.

MANCHESTER.

Literary and Philosophical Society, February 3.—Sir Henry A. Miers, president, in the chair.—Prof. E. **Knecht**: Alpine insolation effects on unprotected wood. Effect of direct sunshine on the wood of Alpine chalets. When exposed for about a hundred years the surface of the wood was sometimes charred or scorched to a uniform black, presenting under the microscope the appearance of coal. The changes were probably brought about more by thermo-chemical than by photo-chemical action. By prolonged heating of wood to 93° C. the author had produced incipient blackening of the surface. The temperature of decomposition of wood appeared to have an important bearing on the question of coal-formation.—W. **Thomson** and H. S. **Newman**: The behaviour of amalgamated aluminium and aluminium wire. Investigations on the fine feathery growths produced when aluminium wire is brought into contact with mercury. No such growths are obtained from amalgamated magnesium, although it undergoes oxidation more readily than aluminium at the ordinary temperatures of the air.—C. E. **Stromeyer**: The after-effects of cannibalism. Cannibalism would not be indulged in by people with vegetarian tastes, or by those who, having a craving for animal food, could satisfy it. Others who had this craving, but no animals to eat, would become cannibals. No State in which indiscriminate man-eating was indulged in could have flourished. Officials were therefore appointed who invented rites which became religious ceremonies. Human sacrifices were, to a certain extent, discontinued, but the rites were con-

tinued. Religious animal sacrifices of the ancients were an after-effect of human sacrifices, as is possibly our practice of saying grace before meat.

PARIS.

Academy of Sciences, February 23.—M. Henri Deslandres in the chair.—M. L. **Mangin** gave an account of the life-work of Emile Boudier, correspondant in botany.—H. **Andoyer**: The method of Gauss for the calculation of secular perturbations.—L. **Maquenne** and E. **Demoussy**: The absorption of calcium by plant-roots and its antitoxic properties towards copper. Calcium does not prevent the absorption of copper by the roots of plants, and copper does not prevent the assimilation of calcium. The antitoxic action of calcium, experimental proofs of which are given, is of a physiological order; it prevents a dangerous accumulation of the poisonous metal.—Y. **Delage**: Suggestion for the reason for the double fovea of certain birds of prey.—W. **Kilian**: The repartition of the facies of the Palæo-Cretaceous in the structural units of the south-east of France.—J. **Hadamard**: Report on the works examined and retained by the Ballistics Committee during the period of the war.—Prof. Michelson was elected a foreign associate in succession to the late Lord Rayleigh, and M. Camille Viguier a correspondant for the section of anatomy and zoology in succession to the late Gustaf Retzius.—N. **Sakellariou**: The oblique linear and surface curvature of a surface.—H. **Villat**: Certain cyclic movements with or without vortices.—C. **Rabut**: Light concrete: the calculation of increase of power resulting from its use in building. Slag concrete is lighter than concrete made up with sand or gravel. A sketch of the theory of its application is given.—P. **Le Rolland**: The influence of the deformation of the knife-edge and of the plane of suspension on the time of swing of a pendulum.—H. **Georges**: A new alternating mercury arc. A description of a new quartz mercury lamp which with electromotive forces of more than 500 volts starts cold.—L. **Guillet**: The alloys of copper, zinc, and nickel. An account of the mechanical properties of alloys containing copper, 46 and 40·5 per cent.; zinc, 43·2 and 44·7 per cent.; and nickel, 10·4 and 14·4 per cent. Comparisons with brasses free from nickel are added. Compared with brass, these alloys possess advantages in colour, greater resistance to oxidation, and facility of forging at high temperatures.—C. **Matignon** and M. **Fréjacques**: The dissociation of ammonium carbamate. Dissociation pressures are given for temperatures ranging from 100° to 150° C.—M. **Tiffeneau** and A. **Orekhoff**: The transposition of the phenyl group in the tetrahydronaphthalene series.—R. **Souèges**: The embryogeny of the Chenopodiaceæ. Development of the embryo in *Chenopodium Bonus-Henricus*.—L. **Emberger**: The evolution of the chondriome in the formation of the sporangium in ferns.—J. **Pottier**: The generality of the foliar asymmetry in mosses.—P. **Dangeard**: The evolution of the vacuolar system in Gymnosperms.—P. **Portier** and Mme. Lucie **Randoin**: The creation of vitamines in the intestines of rabbits receiving nourishment sterilised at a high temperature.

Books Received.

Card Test for Colour Blindness. By Dr. F. W. Edridge-Green. 24 cards. (London: G. Bell and Sons, Ltd.) 25*s*. net.

The Development of the Atomic Theory. By A. N. Meldrum. Pp. ii+13. (London: Oxford University Press.) 1*s*. 6*d*. net.

The Social Worker. By C. R. Attlee. Pp. viii+286. (London: G. Bell and Sons, Ltd.) 6*s*. net.

Smithsonian Meteorological Tables. Fourth revised edition. Pp. lxxii+261. (Washington: Smithsonian Institution.)

The Sumner Line, or Line of Position as an Aid to Navigation. By G. C. Comstock. Pp. vi+70. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 6*s*. net.

Blank Reduction Forms for Line of Position Observations (Marc St. Hilaire Method). By G. C. Comstock. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 2*s*. 6*d*. net

Silvanus Phillips Thompson, D.Sc., LL.D., F.R.S.: His Life and Letters. By J. S. and H. G. Thompson. Pp. ix+372. (London: T. Fisher Unwin, Ltd.) 21*s*. net.

Wild Life in Canada. By Capt. A. Buchanan. Pp. xx+264. (London: J. Murray.) 15*s*. net.

Collected Scientific Papers. By Prof. J. H. Poynting. Pp. xxxii+768. (Cambridge: At the University Press.) 37*s*. 6*d*. net.

The Principles of Aërography. By Prof. A. McAdie. Pp. xii+318. (London: G. G. Harrap and Co.) 21*s*. net.

General Science: First Course. By L. Elhuff. Pp. viii+435. (London: G. G. Harrap and Co.) 5*s*. net.

Quantitative Analysis by Electrolysis. By A. Classen and H. Cloeren. Revised English edition by Prof. W. T. Hall. Pp. xiii+346. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 17*s*. 6*d*. net.

Practical Histology. By Prof. J. N. Langley. Third edition. Pp. viii+320. (Cambridge: W. Heffer and Sons, Ltd.) 10*s*. 6*d*. net.

Fuel Production and Utilization. By Dr. H. S. Taylor. Pp. xiv+297. (London: Baillière, Tindall, and Cox.) 10*s*. 6*d*. net.

History of the Great War, Based on Official Documents. Naval Operations. By Sir Julian Corbett. Vol. i. Pp. xiv+470+vol. of 18 maps. (London: Longmans and Co.) 17*s*. 6*d*. net.

Nature and Super-Nature: A Key to the Spiritual World. By J. Leslie. Pp. 80. (Aberdeen: W. Jolly and Sons, Ltd.) 2*s*.

DIARY OF SOCIETIES.

THURSDAY, MARCH 18.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Stephen Graham: The Spirit of America after the War.

ROYAL SOCIETY, at 4.30.—W. B. Brierley: A Form of *Botrytis cinerea* with Colourless Sclerotia.—R. R. Gates: A Preliminary Account of the Meiotic Phenomena in the Pollen Mother Cells and Tapetum of Lettuce (*Lactuca sativa*).

LINNEAN SOCIETY, at 5.—Dr. J. Small: The Chemical Reversal of Geotropic Response in Roots and Stems.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Sir John R. Bradford: The Clinical Experiences of a Physician during the Campaign in France and Flanders, 1914-1919 (Lumleian Lecture).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. S. V. Pearson: Suggested Reforms in the Campaign against Tuberculosis.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—W. R. Jones: Tin and Tungsten Deposits: The Economic Significance of their Relative Temperatures of Formation.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Adjourned Discussion on the Papers of W. H. Patchell and S. H. Fowles read at the Meeting on March 11.

CHEMICAL SOCIETY, at 8.—I. Masson and R. McCall: The Viscosity of Nitrocellulose in Mixtures of Acetone and Water.—H. Stephen, W. F. Short, and G. Gladding: The Introduction of the Chloromethyl Group into the Aromatic Nucleus.—H. E. Cox: The Influence of the Solvent on the Velocity of Reaction between certain Alkyl Iodides and Sodium β-Naphthoxide.—H. Crompton and P. L. Vanderstichele: The Use of 1:2-Dichlorovinylethyl Ether for the Production of Chloroacetates and Acid Chlorides.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, MARCH 19.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—Sir William S. Meyer: The Indian Currency System and its Developments.

CONCRETE INSTITUTE, at 6.—Dr. O. Faber: The Practical Application of Reinforced Concrete.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—D. Brownlie: Exact Data on the Performance of Mechanical Stokers, as applied to "Lancashire" and other Narrow-flued Boilers.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. H. F. Robba: Shipbuilding and Shipping Developments in Italy.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. A. E. Barclay and Others: Discussion on Radium-Therapy and Radio-Therapy of Exophthalmic Goitre.—Dr. S. Russ: Vision by Ultra-violet Light.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—E. McCurdy: Leonardo da Vinci.

SATURDAY, MARCH 20.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

PHYSIOLOGICAL SOCIETY (at University College), at 4.—J. F. Donegan and Others: Innervation of Veins.

MONDAY, MARCH 22.

ARISTOTELIAN SOCIETY (at 74 Grosvenor Street, W.1), at 8.—C. C. J. Webb: Obligation, Autonomy, and the Common Good.

MEDICAL SOCIETY OF LONDON, at 8.30.—E. M. Little and Others: Discussion on the Re-education of the Amputated.

ROYAL GEOGRAPHICAL SOCIETY (at Philharmonic Hall), at 8.30.—Sir Ernest Shackleton: The 1914-1917 Antarctic Expedition.

TUESDAY, MARCH 23.

ROYAL ANTHROPOLOGICAL INSTITUTE AND PREHISTORIC SOCIETY OF EAST ANGLIA (Joint Meetings) (at Geological Society), at 3.—The Prehistoric Society of East Anglia.—Prof. J. E. Marr: Man and the Glacial Period (Presidential Address).—H. Dewey: Flat-based Celts from Kent, Hampshire, and Dorset.—Dr. A. E. Peake: Exhibit of Specimens found at Grime's Graves in 1919.

ROYAL HORTICULTURAL SOCIETY, at 3.—Rev. J. Jacob: Wandering down Old Garden By-roads.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. Keith: British Ethnology—The Invaders of England.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Sir John R. Bradford: The Clinical Experiences of a Physician during the Campaign in France and Flanders, 1914-1919 (Lumleian Lecture).

INSTITUTION OF CIVIL ENGINEERS, at 5.30.—Col. D. Lyell: The Work done by Railway Troops in France during 1914-1919.

ROYAL ANTHROPOLOGICAL INSTITUTE AND PREHISTORIC SOCIETY OF EAST ANGLIA (Joint Meetings) (at Geological Society), at 6.—Prof. A. Keith: How Far Cranial Characters can Help in Estimating the Antiquity of Human Remains. (Lantern.)

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—Dr. B. Glover: Factorial and Time Methods of Development applied to Bromide and Gaslight Papers: Theoretical Principles and Practical Demonstrations.

FARADAY SOCIETY (at Chemical Society), at 7.30.—General Discussion:—Basic Slags: Their Production and Utilisation in Agricultural and other Industries. Prof. F. G. Donnan will preside over the discussion.—Dr. E. J. Russell will open the discussion and give a general survey of the subject.—Prof. C. H. Desch will discuss the subject from the Physico-Chemical Standpoint.—Sir T. H. Middleton: The National Aspects of the Case for Increasing the Supplies of Basic Slag.—Sir A. Daniel Hall: The Demand for Basic Slag.—Prof. D. A. Gilchrist: Basic Slag and its Place in the Development of Agriculture.—G. Scott Robertson: A Comparison of the Effect of various Types of Open-hearth Basic Slag on Grassland.—Dr. J. E. Stead, F. Bainbridge, and E. W. Jackson: Papers on Solubility of Basic Slags.—D. Sillars: The Formation of Basic Slag in the Manufacture of Steel.—W. S. Jones: The Improvement of Low-grade Basic Slag.

WEDNESDAY, MARCH 24.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11.—The Earl of Durham: Presidential Address.—Sir Eustace D'Eyncourt, H.M.S. *Hood*.—A. W. Johns: German Submarines.—G. S. Baker: Mode Experiments in Connection with Submarine Warfare.

ASSOCIATION OF ECONOMIC BIOLOGISTS (General Meeting) (in Botany School of the Imperial College of Science and Technology), at 11.30.—Short Communications and Exhibitions.—D. W. Cutler: The Relation of Protozoa to Soil Problems.—Winifred E. Brenchley: Correlation between Seed and Crop.—At 2.15.—Dr. W. Lawrence Balls: The Nature and Scope of Botanical Research in the Cotton Industry.—M. C. Rayner: The Calcifuge Habit in Ling (*Calluna vulgaris*) and other Ericaceous Plants.—H. Wormald: Shoot Wilt of Plum Trees.

ROYAL SOCIETY OF ARTS, at 4.30.—L. Gaster: Industrial Lighting in its relation to Efficiency.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Mrs. E. M. Reid: Two Pre-Glacial Floras from Castle Eden, Durham, and a Comparative Review of Pliocene Floras, based on the Study of Fossil Seeds.

PSYCHOLOGICAL SOCIETY (Industrial Section) (at Examination Rooms of the Royal College of Physicians, 8-11 Queen Square, W.C. 1), at 6.—Miss G. Broughton: The Psychological Causes of the Wastage of Labour in Factories employing Women.

THURSDAY, MARCH 25.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11.—Sir Alfred Yarrow: Notes on our Economic Position as a Shipbuilding Country.—J. Anderson: Further Notes on the Dimensions of Cargo Steamers.—Dr. J. Bruhn: Freeboard and Strength of Ships.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 3.—P. R. Jackson: The Stabilisation of Ships by means of Gyroscopes.—Prof. K. Suyehiro: Yawing of Ships caused by Oscillation amongst Waves.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Stephen Graham: The Hope for Russia.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Prof. A. R. Forsyth: Note on the Central Differential Equation in the Relativity Theory of Gravitation.—R. D. Oldham: The Frequency of Earthquakes in Italy in the Years 1896 to 1914.—A. F. Dufton: A New Apparatus for Drawing Conic Curves.—Capt. J. W. Bispham: An Experimental Determination of the Distribution of the Partial Correlation Coefficient in Samples of 30.

CHEMICAL SOCIETY (Annual General Meeting), at 5.—Sir James J. Dobbie: Presidential Address.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Sir John R. Bradford: The Clinical Experiences of a Physician during the Campaign in France and Flanders, 1914-1919 (Lumleian Lecture).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. E. Sloan Chesser: Adolescence and the Continuation Schools.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Discussion on:—(*a*) The Electrical Equipment of Artisan Dwellings (with Introductory Paper by L. Milne). (*b*) The Report of the Farthing Sub-Committee of the Wiring Rules Committee of the Institution.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 7.30.—C. I. R. Campbell and C. H. May: The Effect of Size upon Performance of Rigid Airships.—Prof. E. G. Coker and A. L. Kemball, jun.: The Effects of Holes, Cracks, and other Discontinuities in Ships' Plating.

CHEMICAL SOCIETY (Informal Meeting), at 8.

FRIDAY, MARCH 26.

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 11.—Eng.-Com. H. B. Tostevin: Experience and Practice in Mechanical Reduction Gears in Warships.—J. J. King-Salter: The Balancing of Rotors and Determining the Position and Amount of the Balancing Weights.—Prof. T. H. Havelock: Turbulent Fluid Motion and Skin Friction.

PHYSICAL SOCIETY OF LONDON, at 5.—Prof. A. S. Eddington and Others: Discussion on Einstein's Theory of Relativity.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—Capt. L. A. T. Broadwood: Harmonics in Continuous Wave Transmissions (Illustrated by Lantern Slides and Experiments).

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—P. L. Young and Others: Discussion on Foundry Memories.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir J. J. Thomson: The Scientific Work of the late The Right Hon. Lord Rayleigh.

SATURDAY, MARCH 27.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir J. J. Thomson: Positive Rays.

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